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As one of its major activities in carrying out its purpose, the Society publishes a monthly magazine, the Canadian Geographical Journal, which is devoted to every phase of geography—historical, physical and economic—of Canada, of the British Commonwealth and of the other parts of the world in which Canada has special interest. It is the intention to publish articles in this magazine that will be popular in character, easily read, well illustrated and educational to the young, as well as informative to the adult.

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SPECIAL REPRESENTATIVES:

Ontario and Quebec: F. A. DALLYN

Toronto office — 21 King Street, E. (Tel. EMpire 4-2863)

Montreal office — 1,000 St. Antoine Street, (Tel. UN. 5285)

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Ontario Dept. of Lands and Forests

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Left:—Tall spikes of blue lupin and pale mountain avens bloom in the far north.
Colour photograph by A. E. Porsild

Felling white pine near Chapleau, Ontario

Timber Management In Ontario

by J. A. BRODIE

The Earlier Developments

FOREST industry and forest management in Canada go back to the days of the earliest settlers. Both the French and the British colonists came from countries where the pinch of failing timber supplies, especially for naval purposes, was already acute. The reservation of naval timber was a pronounced policy on the part of the French and British governments in their oversight of the settlements of North America. The earliest French colonist could not clear his land until the suitable oak, and later the pine trees, had been marked and reserved for the use of the King's Navy. As the best trees grew on the soils best adapted to agriculture, the strict enforcement of the regulations and the heavy fines imposed for infractions spelt hardship for the settlers.

James Murray, the first Governor under the British regime, was, in 1763, instructed by the King that when new townships were laid out, all land unfit for agriculture should be set aside under the Crown for the purpose of growing naval timbers. The succeeding Governors received similar instructions. Here was the beginning of a definite policy of forest conservation, based on recognition of the principle that non-agricultural land should be dedicated to forest production.

The timber licence system was introduced in 1826 for the direct purpose of obtaining revenues, and, in that respect, it has been a financial success. At present, thoughtful people, both within the Government and outside it, are considering and weighing the value of immediate revenues as a public objective, if they are gained at the expense of future prosperity. The province has a long time ahead of it. Prosperity does not just happen—it is the product of foresight and good management. This fact becomes increasingly apparent in the field of forest development and administration as we gain a clearer view of the limits of our resources.

In 1897 a commission was appointed "to investigate and report upon the subject of restoring and preserving the growth of white pine and other timber trees upon lands in the Province of Ontario which are not adapted for agricultural purposes or for settlement". As a result of its report the Forest Reserves Act 1898 established four of the seven reserves that are now set apart under the Provincial Forests Act passed in 1929. The commission recommended the enforcement of regulations to prevent too close cutting upon lands under licence. It was the evident intention of the Forest Reserves Act to promote some form of forest management within these reserves. This intention was made more specific thirty years later by the Provincial Forests Act, which changed the name from Forest Reserves to Provincial Forests and provided for their active management. However, during the fifty years since their establishment, certain of the timber lands in these reserves have been put under licence to sawmill operators and the methods of logging have not differed from those employed outside.

The Rise of the Pulp and Paper Industry

In 1859 William Angus and Thomas Logan perfected a process for the manufacture of wood pulp and paper, and established the first soda pulp mill in Canada in 1864. About the same time Canadian papermakers were studying the possibilities of using mechanical pulp for the manufacture of cheaper papers. The first mill using the sulphite method was established at Cornwall in 1888. Sulphate or kraft pulp was first produced in Canada in 1907. Kraft products, first used mainly in the production of wrapping papers where strength is required, now include such widely used products as building papers and paper boards used in the manufacture of packages and shipping containers and for construction and insulating purposes.

Photographs, except one, courtesy Ontario Department of Lands and Forests

The first agreement in Ontario for the supply of pulpwood from Crown lands was approved in 1894, to supply a mill to be constructed at Sault Ste. Marie. By the turn of the century the industry was well established at Sault Ste. Marie and Sturgeon Falls. The manufacture of sulphate or kraft pulp and its products, established early at Dryden on a small scale, has been extended in the past decade by the construction of three large industrial plants at Red Rock, Terrace Bay, and Marathon, and by the conversion of another large plant at Espanola. The expansion of the manufacture of kraft has led to the utilization of jack pine and hardwood species by the pulp and paper industry—in addition to spruce and balsam, the preferred species for sulphite and mechanical pulp.

A Modern Industrial Giant

It would be difficult to over-estimate the importance of the pulp and paper industry in the present-day industrial life of Ontario and of Canada as a whole. The title "Canada's Leading Industry" was regained in 1947 by the pulp and paper industry after it had been conceded for a time to the war industries. It is a title that takes into account such important factors as value of production, employment, materials and supplies purchased, and power consumed.

The gross value of pulp and paper products for the Province of Ontario reached the $272,000,000 mark in 1948. Salaries and wages for employees in the forest and in the mill now run close to $52,000,000. The gross value of production of the sawmilling industry in Ontario amounted to $59,000,000 in 1948 with salaries and wages aggregating $13,000,000. The pulp and paper and sawmilling industries together employ 30,000 workers in the bush and an additional 25,000 men the year around in the mills. The livelihood of thousands of others is affected by the expenditures of these industries on wages, services and supplies—through which $175,000,000 annually permeates into the general business life of Ontario. Supporting the farm economy of the province the bush camps consume probably 150,000 pounds of foodstuffs and provisions daily, costing around $7,000,000 in a season, a valuable home market. Obviously, the ways and means of perpetuating these forest industries is both a provincial and a national interest of the first order.

What is Timber Management?

The answer to this question requires, first of all, a close look at certain basic economic facts. The investment in plant and equipment to construct a pulp and paper mill is of the order of $80,000 per ton of daily paper capacity. Capital costs of that magnitude call for a policy for the supply of raw materials differing radically from that for the supply of a sawmill industry. The licences to cut timber are renewable annually in the case of the sawmilling industry, as contrasted with leases for twenty-one-year periods in the case of the pulp and paper industry. The principle in allocating Crown timber areas to the pulp and paper industry has from the start been to provide a tract on which regrowth would produce raw materials in perpetuity. This idea was set out in concrete form for the first time in the Pulpwood Conservation Act of 1929. The basic idea in this act is contained in the words "sustained yield basis". Here we have the core of sound timber management. Ontario's forests are to be managed so as to yield periodical crops in perpetuity. The ultimate object of all properly directed effort in forest crop production is a sustained yield, in order that continuous revenues may be obtained from forest lands, and that the wood using industries may have at their disposal continuous supplies of raw materials. Moreover, it is essential to seek the maximum yield of the desired marketable quality and species.

To the forester the expression "sustained yield basis" means the maintenance of a sufficient forest area to meet the needs of the mill, with a distribution of age classes that will fit in with the rotation periods of cutting. Heretofore, the methods pursued have

Aerial view of a big paper mill at Kapuskasing. Floating logs and stockpiles await use in the mill and many railway tracks serve it.

Spruce Falls Power and Paper Company

been more haphazard. Trees have been cut at the convenience of the cutter and certainly without consideration of their future value. Under Ontario's present plans the long-term public interest will become the first consideration.

Shortly after the passage, in 1929, of the Provincial Forests Act and the Pulpwood Conservation Act the economic depression of the nineteen-thirties set in, followed by the second world war. Thus the whole period between 1930 and 1945 was unfavourable as far as the advance of forestry was concerned, due to the lack of funds during the depression years and, later, due to war conditions. It was not until 1946 that the Ontario Department of Lands and Forests* was able to give material effect to the principle laid down some fifteen years earlier.

The leading thought in the management of a forest property is permanency—the continued production of crops which take a century or more to produce. The farmer sows his crop in the spring and harvests it for the most part in the same year. The forester must wait for 60 to 100 or more years between sowing and harvesting. He must carry an investment in growing timber fifty times as great in volume as the annual crop harvest. In addition to maintaining these reserves, the age classes of the timber must be such that an approximately equal volume will mature each year. It will always be difficult to convince a wood hungry nation of the necessity of maintaining adequate reserves of growing timber to furnish the relatively small annual wood harvest. The urge for immediate gratification of wants does not tend to make people readily adaptable to the principle of sustained yield timber management.

The Approach to Sound Management

The first requirement is to become thoroughly familiar with all the details of the forest property. Accurate maps must be prepared on which the forest conditions are outlined. The stand of merchantable timber and its location must be determined. The rate of growth should largely govern the

**Department* throughout the article refers to the Ontario Department of Lands and Forests.

High school students pl ed pi

Stumps in eroded land, Durham Count Win

amount of the annual cut. Combined with these are required economic and social surveys of the forest area, especially as they bear on the management of the forest resources.

In order to obtain the required basic information the Forest Resources Inventory Section was set up in the Timber Management Division of the Department in 1946. Several specific questions are to be answered by the inventory. What are the total quantities and the locations of merchantable timber in the Province of Ontario by species and products ? What is the annual allowable cut, on a sustained yield basis, by species and products ? Is there room for further expansion of wood using industries without endangering the future permanence of established industry ? If so, where, and to what extent ? Can the province continue to permit the export of pulpwood in the unmanufactured state without endangering the supply for the established industry, and its orderly expansion ? Subsidiary to the main purposes, the resources inventory supplies improved planimetric maps of the forest area for fire protection, game management and other administrative purposes.

The main work of the forest resources inventory was scheduled to be completed by the end of 1952. The area to be covered includes the section of the province producing accessible merchantable timber, extending from Kawartha Lakes north to and beyond the transcontinental line of the Canadian National Railways running through Cochrane, Hearst, Armstrong and Sioux Lookout. In many sections the accessible forest extends some distance north of this railroad. Southern agricultural Ontario and the sparsely wooded lands on the northern James and Hudson Bay drainage are eliminated from the survey.

Co-operation is not only a more attractive word than dictation, it is a more effective way of doing business. Through the Forest Management Act 1947 and through many of the agreements with corporations for the supply of pulpwood from the Crown domain, the principle of co-operation with industry in making the inventory and in formulating management plans is firmly established. In effect, the industry tells the Department how much timber it has, and how it intends to place its holdings on a sustained yield basis. The Department makes the inventories and plans for the unalienated timber resources, and is responsible for collecting and consolidating the information from all sources. Through this joint effort the inventory is proceeding —with all holdings aggregating fifty square miles or over being covered by industry and the balance by the Department. The arrange-

ents pl ed pine in Hastings County.

County Windbreak of ten-year Scotch pine.

ment is just about a fifty-fifty affair with 80,000 square miles for industry and 85,000 square miles for the province, to make up the total of some 165,000 square miles.

Survey Methods and Progress

Forestry in Ontario took to the air in 1921. The first use of aircraft by the Department of Lands and Forests was for forest inventory. Aerial sketching was the forerunner of aerial photography and still occupies an important place in forest inventory work. The first aerial photographs for mapping and inventory purposes were taken by the Department in 1926. During the following twenty years the technique of forest inventory by the aerial photographic method was gradually perfected in the Aerial Surveys Section of the Department, deriving full benefit from the research work in Canada and elsewhere, to emerge as a full-fledged method in its own right after World War II.

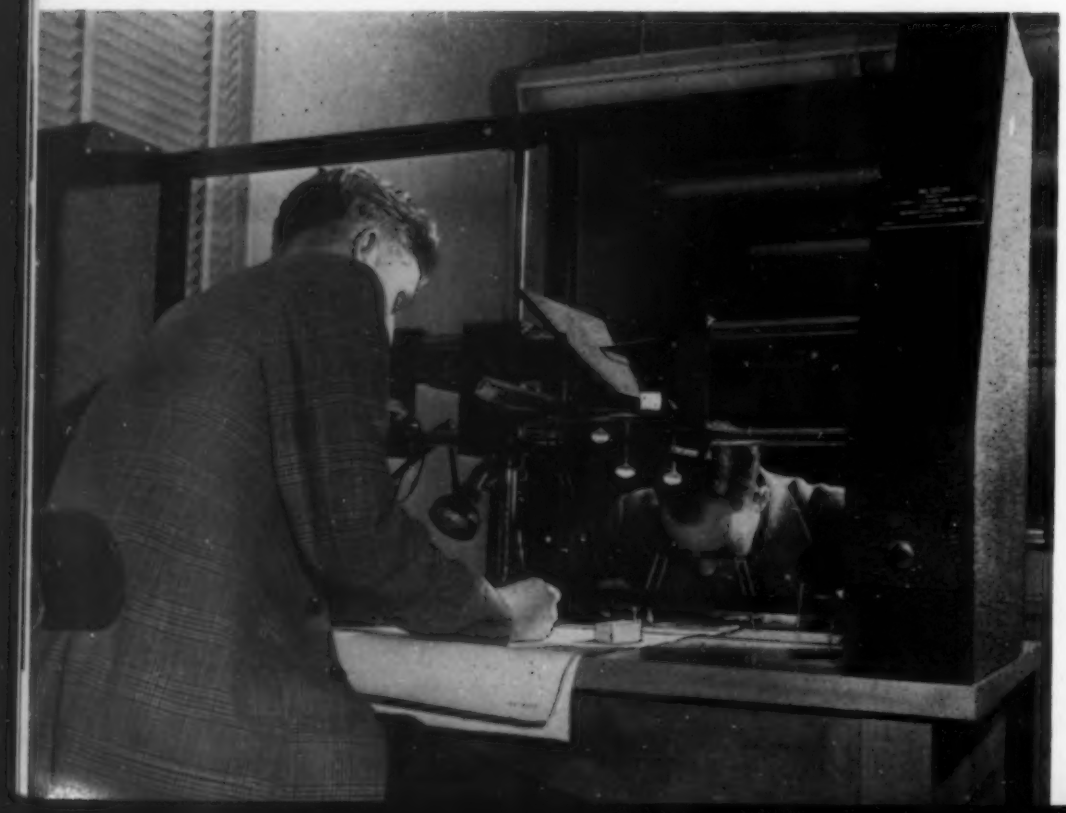
The aerial photographic method of the forest resources inventory is carried out in six well defined steps:

1. Aerial photography.
2. Preparation of planimetric base maps.
3. Forest types interpreted and marked on photographs and transferred by sketchmaster to planimetric base maps.
4. Field checking of forest type maps, and collection of volume and growth data in the field.
5. Preparation and drafting of final forest type map.
6. Compilation of quantities of merchantable timber, growth data, and issuance of final inventory report.

Up to December 1950, the total area photographed amounted to 153,174 square

Checking detail on base map with aerial photograph.

Beaver aircraft in flight, Sudbury, 1948.



Detailed examination of aerial photographs.

General view of workroom, forest resources inventory office.

miles, 126,627 square miles under contract by the Photographic Survey Corporation and 26,547 square miles by the Aerial Survey Section of the Department of Lands and Forests. Planimetric base mapping has been completed for an area of 150,947 square miles (126,627 square miles by the Photographic Survey Corporation and 24,320 square miles by the Department). Field checking and compilation of inventory data are complete for an area of 36,120 square miles of Crown timber lands. Field work was completed on an additional area of 18,200 square miles during the summer season of 1950. Field work and compilations by the industry are keeping pace with the work of the Department. Results of the inventory will be issued in eighteen interim reports, each covering an administrative district of the Department of Lands and Forests. All the work will be brought together in a final report covering the province. Reports for the North Bay, Timiskaming and Cochrane Districts are now being prepared. The report for the North Bay District will be issued in 1951.

The kingpin in the aerial photographic method of forest inventory is the photo-interpreter. His work is tedious and exacting, and on his skill, patience and training the accuracy of the result is mainly dependent. He is usually a university graduate. Typical training consists of two seasons of summer field work, under a trained interpreter. Photographs are carried in the field, giving an opportunity to study the photographic image and the forest at the same time. The winter season from October to May is spent, still under supervision, in interpreting from the aerial photographs alone. All of the work is checked by a supervisor until such time as a high degree of proficiency and accuracy is attained. Training is completed by an additional

Young foresters work on preparation of photo map.

summer spent on checking office interpretation in the field.

There is an air of expectancy around the Forest Resources Inventory offices as the first warm days of spring arrive, for by May 24th the whole centre of work is transferred to the field. The photographic method has taken much of the drudgery out of the earlier systems of ground work only, and has transformed forest survey work into a highly skilled, specialized, professional undertaking. As is usually the case where research and science have wrought such transformations, the costs have been reduced and the accuracy and usefulness of the results immeasurably increased.

The field work is carried out by crews of six men. The technical staff of each crew includes a graduate forester as party chief, a third year forestry student, with usually two seasons' experience, and a second year student with one year's experience. The field supervisors have four crews to look after, and the whole is under direction of the general supervisor. Each crew covers during a summer from 1,500 to 2,000 square miles. Usually a total of about 18,000 square miles constitutes a full season's work. Each crew takes with it the preliminary forest type maps prepared during the winter, and the aerial photographs of the area to be worked over. The most important work of the field crews is the measurement of the forest growth on sample plots.

Travel and transportation of field parties from point to point are as varied as the exigencies of the terrain dictate, and extend all the way from the most modern move-

ment by aircraft down to the most primitive foot slogging. The use of aircraft for transport of personnel has permitted a much wider sample plot distribution, which is fundamental to the success of the selected sample plot method of inventory.

On the closing of the field work in September, work again gets under way in the office, preparing the finished type maps to be handed over to the drafting department for making of the final tracings and plans. Compilation crews work out the merchantable volume figures, growth and yield and other data and assemble them into systematic tabular form for use.

The physical assets of the Forest Resources Inventory will consist of 150,000 aerial photographs of high quality covering the forested area of the province. These will be of value for many years to come for all branches of forestry work and, in addition, will contribute to the progress of mining, hydro-electric power planning, highway construction and generally to all phases of natural resources development. There will be 1,600 sheets of planimetric base maps, on a scale of four inches to the mile. These will form the base for all published maps of the province. Through an arrangement with the Army Survey Establishment, Department of National Defence, completely new maps on a scale of two miles to the inch and four miles to the inch are being published for general use. A second series of forest type maps, 1,600 in all, is being prepared as the inventory progresses, on a scale of four inches to the mile, showing forest conditions and all other features of value in planning forest management.

The tabular statements accompanying the forest resources inventory show the volume of timber by species, types and age classes in such a way that the total volume of merchantable and other timber in a township, watershed, district, or in the province as a whole, can be readily obtained.

These physical assets, useful in so many different ways, find their final value in furnishing the foundation for the management of the forest resources of the province on a sustained yield basis. It is only in their value for this purpose that the work and expense can be fully justified. Forests produce many benefits over and above those derived from the timber and wood products placed on the market. They are the habitat for game, and create the environment suitable for game fish in the waters of our streams and lakes—prime factors in developing and sustaining tourist business. They influence climate, prevent erosion and rapid run-off of water, and are thus a vital asset to hydro-electric power development. Some of these benefits may be attainable with any tree cover but all of them are served best by a healthy, growing forest cover. Forest management—viewed primarily as the business of growing timber crops of the best species for profitable markets—fulfils the economic purpose of providing "the greatest benefits for the largest numbers". For, in addition to serving the main incentive of scientific forestry—the necessity of obtaining assured and adequate wood supplies—forest management serves at the same time many other purposes of the utmost social and material value.

Checking position on the map while on survey operations.

Forestry in Ontario

Forestry in Ontario is now based on a long period of experiment and experience. Reforestation of waste lands, commenced in 1905, has developed steadily over a period of forty-five years. Many of the earlier plantations are now being further treated and products placed on the market. In 1917 the forest fire protection system was reorganized along modern lines adequate to meet the continually increasing fire hazard in the woods. Aircraft were used in Ontario as early as 1921 for patrol and fire suppression. Since that time the wider use of aircraft in forestry work generally has been pioneered in Ontario where the terrain and problems have made its ready adaptation conspicuously effective. The system of fire detection based on a lookout tower grid, with a specialized type of ultra-high frequency radio communication, augmented under conditions of high hazard or of limited visibility by aircraft patrol, is considered the most effective detection system in use anywhere.

Forest research, begun in 1930, was extended in 1943 by the establishment of the Southern Ontario Research Station. In a similar field forest insect control has developed along radically new lines at the Forest Insect Laboratories at Sault Ste. Marie, Ontario—here again, adapting the method of approach to the problems as they present themselves locally. The development and perfecting of the aerial photographic method of forest survey may be considered an achievement which will continue to have a far-reaching influence on the continued progress of scientific forestry in Ontario. Scientific forestry in Ontario has thrown off its swaddling clothes—dependence on methods and procedures from elsewhere—and having attained full stature is capable of solving its own problems and of contributing its portion to world forestry progress.

Top left:—The forester in a Beaver aircraft spots smoke column and circles it.

Extreme left:—Fire fighter with a pack pump.

Left—Digging a fire break.

Top right:—Map showing fire along railway.

Right:—Tisdale observation tower.

Examination of a log disk (top) and identification of insect larvae (lower) at the Forest Insect Laboratory, Sault Ste. Marie.

What does scientific treatment of our forests mean? Primarily it means a different attitude: consideration of timber as a crop capable of reproduction rather than as a mine that will eventually be exhausted and closed up. Instead of allowing the lumberman or pulpwood operator to cut and utilize all of the best marketable species and to leave the rest and the slash to make fuel for forest fires, or permitting a reproduction of species good, bad and indifferent as nature might chance to establish, the forester first ascertains in detail the character of the forest property—he takes an inventory. He then makes a working plan, in which is determined the amount that can be cut annually and yet assure continuous crops. He proceeds to cut with a view to securing a new crop, improving the composition of the forest by removing weed trees, trees of low value and poor form, to give a better chance for the valuable species and then cutting the old crop gradually, as the young crop seeds in and needs more light and space. By another method he may cut the entire stand but if a new crop does not seed in naturally, planting must follow, because one unfailing rule of the managed forest is to leave a growing forest crop in place of the harvested one.

Following the completion of the forest resources inventory, working plans will be prepared for the forested area of the province. These will vary in size of operation and, due to the differences in forest and other conditions locally, will vary widely from intensive management requirements to more general prescriptions, possibly in some cases amounting to no more than conservative logging.

The foregoing relates to the technical side of forestry—to the actual work of the forester. It has to do with the application of policies rather than with their formulation and adoption which is a function of governments and of the people. Forest facts and data supplied by the forest resources inventory are not all that a government must consider in formulating forest policies. The technical soundness of management plans will rarely be questioned—their effect on people and communities will be the main points at issue. Ontario's forest industries have, through generations, become closely integrated with the general economic structure of the province, and public policies in relation to forestry must be framed with full

regard to what is in the best interest of the provincial economy as a whole. The proper alignment of technical forestry with the needs and wishes of the people and with the general economic interests of the province as a whole, through a minister responsible to the elected representatives of the people in the legislature, is one of the strong features of our form of government.

The present greatest activity in forest management work is necessarily centred around the forest resources inventory. On its completion in 1952 the main effort will be directed to actual management. However, it is not necessary to await the completion of the inventory before certain phases of forest management are undertaken.

The building up of a forest management staff to supply adequate supervision and control of woods operations was started in 1946 and has proceeded on an increasing scale. For this work alone 42 foresters and 22 other personnel have been added to the staff. Many of these are engaged on the inventory but it has been possible to assign 22 men to field work on operations in Northern Ontario. It is planned to bring the number of new staff assigned to field supervision of operations to a total of 54 by 1952 or as soon as suitable men can be recruited and trained.

Although management plans for the province as a whole must await the completion of the inventory, many plans are already in operation in areas where inventory figures and maps have been prepared. Management plans or working plans, as they are usually termed by the forester, are prepared for specific areas of forest constituting the supply area for a manufacturing plant, or a group consisting possibly of a pulp and paper mill and sawmills, or, depending on the forest composition, one or more miscellaneous wood using industries which may include veneer manufacture, flooring, poles and so on. Several plans are in operation for pulp concession areas and the plan for the Petawawa Management Unit is in operation, supplying a part of the requirements of the wood using industries in the city of Pembroke and vicinity. This is the beginning of a project designed to rehabilitate the old pineries of the Ottawa-Huron area, a long-term undertaking designed to bring this area back to a production of red and white pine lumber similar to the early logging days in Ontario.

Plan for a Pulp Concession

A short description of a working plan for a pulp concession area in northern Ontario follows as an illustrative example.

The Forest Insect Laboratory at Sault Ste. Marie.

The concession area contains 942,103 acres of productive forest land and 207,420 acres of water and non-productive land, the latter representing 18 per cent of the total area in the concession. This area contains 4,938,000 cords of spruce and balsam, 3,255,000 cords of jack pine and 3,150,000 cords of poplar, due allowance having been made for estimated losses, especially those resulting from the spruce budworm epidemic.

It is planned to operate only the east part of the concession during the next three-year period, comprising an area of 475,000 acres or about 50 per cent of the productive forest land and 45 per cent of the mature and overmature spruce, balsam and jack pine. The immediate objective will be to establish permanent operations wherever the volume and condition of the timber make this possible. In areas where the timber is predominantly mature and overmature and where the spruce budworm damage has been excessive, cutting operations designed to salvage as much of this wood as possible in the shortest period of time will be planned.

The annual allowable cut for the entire concession is 148,200 cords, composed of 103,500 cords of spruce and balsam and 44,700 cords of jack pine. Since only half of the area is included in the present plan the allowable cut for the area under consideration is 74,000 cords. This is composed of 52,000 cords of spruce and balsam and 22,000 cords of jack pine, and corresponds to a yield of about 0.15 cords per acre per year. Since 91 per cent of the volume of spruce and balsam and 75 per cent of the jack pine on this area is in the mature age class, and because budworm damage is present, the initial periodic cut will exceed the allowable cut.

The average annual planned cut for the next three-year period will be 84,500 cords, composed of 65,000 cords of spruce and balsam and 19,500 cords of jack pine. Approximately 17,000 cords of jack pine, or 87 per cent of the planned cut of jack pine, will be produced for railway ties and sawlogs as long as market conditions are favourable.

During the three-year period of the initial plan there will be four camps in operation, cutting a total of 84,500 cords. This production can be maintained for a short time beyond the three-year period without sacrificing the permanency of the operation. To maintain this level of production beyond five years the balance of the concession area must be opened for operations.

Camp No. 1 to commence operations in the fall of 1950 will produce 10,000 cords per year. Only 6,000 cords will be spruce and balsam. This is a higher cut than this camp can sustain but because of the large volume of overmature timber this cut will be sustained for a period of five years, falling

Girls on the production line at a mill in New Liskeard.

Scaling scorched white pine logs salvaged from fire.

then to 5,000 cords annually on a permanent basis.

Camp No. 2 will operate at a rate of 20,000 cords for the three-year period after which it will fall to 7,000 cords yearly for permanent operations.

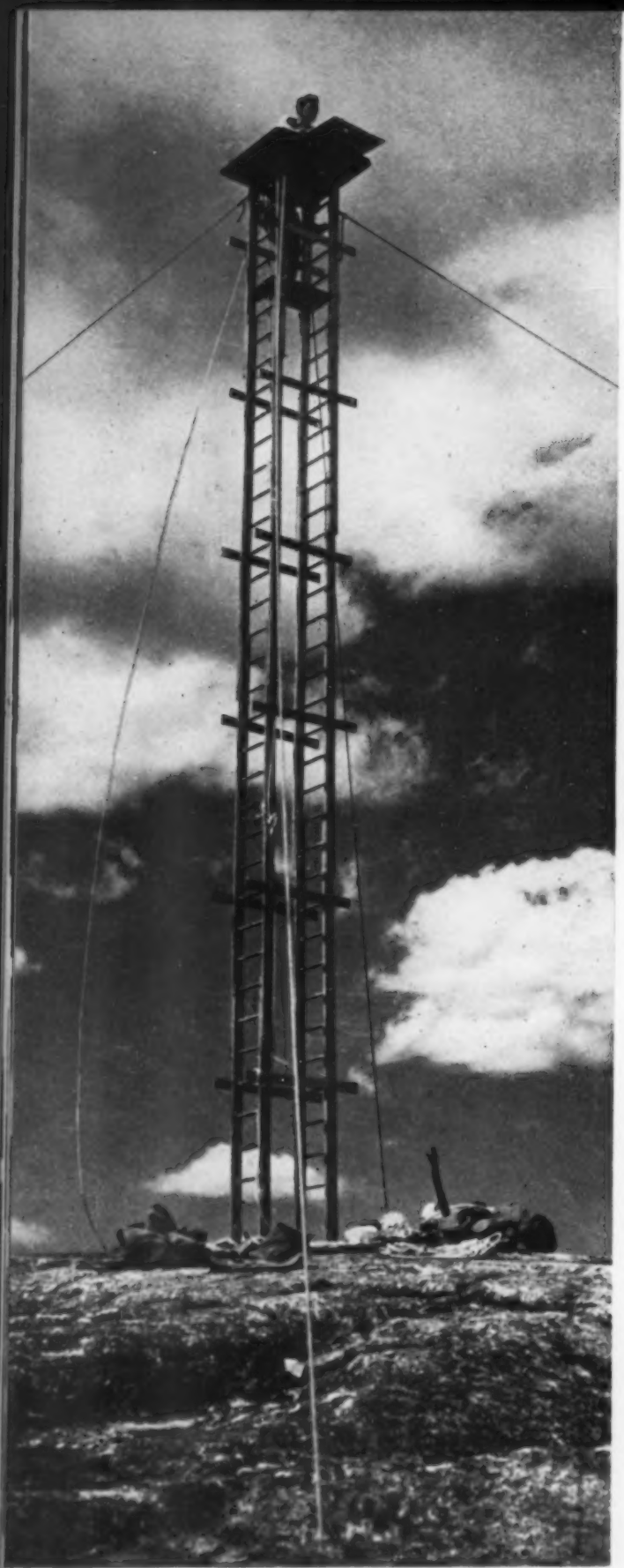
Camp No. 3 is also scheduled to operate at 20,000 cords. This cut is about twice the allowable cut and will be reduced to 10,000 cords per year after three years.

Camp No. 4 will furnish the balance of the wood requirement and the permanency of this operation will be sacrificed in order to salvage as much of the budworm damaged timber as possible in the shortest time.

Along with the working plan, described here in outline, go maps showing the location of timber, camps and operating areas along with roads and other improvements, and tabular statements of quantities of standing timber and calculated allowable cuts to make the complete plan. The annual allowable cut depends partly on the volume of standing timber but more essentially on the growth rate or actual production of the area. Good forestry practices will increase the growth rate and the allowable cut, while poor practices will reduce it. A running inventory of the quantities of timber on the area gives the necessary data to adjust the annual cut to correspond to the allowable cut which may vary considerably up or down throughout the rotation.

Working Plans

On completion of the inventory the making of working plans, similar to the above in



broad outline and covering the forest area of the province, will be undertaken. There will probably be about one hundred separate plans which, added together, will form the plan for the province as a whole.

These working plans will provide for the continuous operation of camps where forest conditions permit, with all of the social benefits of a stable economy. They will provide for the maximum utilization of the forest to supply the market and for the salvage of material damaged by the spruce budworm or otherwise.

It is the Canadian market, and only that, which makes the practice of forestry as a business different in Canada from that of Europe, and this, again, is due to the difference in density and distribution of population. The European wood market is in most parts largely a local market. Local consumption is steady, continuous and ample. Utilization down to small brush is possible through local consumption by a dense population living on a relatively low standard. An intensive management pays best.

The Canadian wood market is essentially continental. A major part of the wood and wood products cut in Ontario is consumed at a distance. Cheap transportation over long distances is the key-note of profitable marketing. This requirement rules out in many districts any thorough utilization of the product. Inferior kinds, inferior parts of the forest, must be left unused. Extensive management is a necessity in the use of our forest resources on account of the absence at the points of production of a local population to use the inferior material. In Canada, a definite, stable, continuous market is dependent on the establishment of local wood-consuming factories, using the inferior species and products of the forest and manufacturing them into products that may stand transportation charges and be sold profitably in markets

Field worker sketching from top of portable tower.

View from top of new Brigstocke steel tower, North Bay district.

some distance from their source of origin.

In the illustrative management plan, described above, there is no market for most of the 3,150,000 cords of poplar. Although the market for poplar is increasing there is still much more of it in the forest than present industry is utilizing It is still uncertain whether the market for jack pine will be sufficiently continuous to permit the utilization of the entire allowable cut of this species. The situation regarding the use of these species and others has been improved during the past decade by the opening of four large sulphate mills, and by the conversion of the Sturgeon Falls mill to the utilization of hardwoods for the manufacture of pulp by a relatively new process. Developments along this line are continuing, leading to a more thorough utilization of the forest crop.

Five primary essentials must be the basis of a system of timber management.

1. Inventory—a thorough knowledge of the forest property.
2. Improved inspection and control of woods operations.
3. Working plans—specific measures to be followed for each management unit.
4. More thorough utilization of the forest crop, involving problems of transportation, harvesting and planned industrial development.
5. Silvicultural methods of logging so as to produce a desirable new crop.

BIRD SERIES — PART X

Photographs and Notes by W. V. CRICH

COOPER'S HAWK *ACCIPITER COOPERI*

COOPER'S HAWKS are ferocious bird-hunters. Their misdeeds, when viewed from the human standpoint, bring disfavour upon our large rodent-eating hawks, which do not share in the harmful depredations of the Cooper. The former are of great benefit to man. The hunter looking for "vermin", or the farmer who has lost some small chickens, view all hawks alike, and the innocent suffer for the guilty.

Cooper's Hawks construct their nests in the crotches of trees, generally at a considerable height above the ground. The nest is made of sticks, and is often lined with pieces of bark. Bits of down decorate the nest. From the ground these show the nest to be occupied, even when the long, projecting tail of the incubating adult is not visible. Four or five nearly white eggs are laid. Incubation is shared by both parents and lasts for about twenty-four days. The eggs hatch at about the same time, and there is not the difference in the size of the young that is quite often the case in other species.

When first hatched, the young are covered by short, white down, slightly tinged with yellow. This is later replaced by long, woolly, pure white down. In the photograph of the four young, the juvenile plumage has started to grow, and shows on the wings and tail of those pictured.

The third picture shows an immature hawk recently out of the nest and trying its wings. It is now in complete juvenile plumage in which it will start to breed the following spring. It will be two years before the hawk appears in complete adult plumage. The top photograph on the opposite page shows an adult bird.

The food of this hawk includes small chickens and ducks, pigeons, game birds and other wild birds, small mammals, frogs, and snakes. These it hunts in a low, swift flight which catches its prey unprepared and without a chance to escape. Its short wings and long tail give it the ability to dash in and out of thickets with terrific speed in its search for victims.

Plant Life

fe in the Arctic

by A. E. PORSILD

Photographs by A. E. Porsild and the National Museum, except where otherwise noted

ASIDE from specialists, very few people realize that as far north as land reaches towards the North Pole, botanists have found numerous species of flowering plants besides such lower forms of plant life as mosses, lichens, algae and fungi.

From North Greenland, north of the 80th parallel of latitude, no less than seventy-six species of flowering plants and ferns have been recorded. Near Cape Bridgman, in latitude 83° 39′, 400 miles from the North Pole, Danish explorers found a number of plants in full bloom. Several of these plants grow also at sea level on the north shore of the Gulf of St. Lawrence or at Gaspe and in the west on the mountains near Banff, Alberta. In Ellesmere Island and in Greenland north of latitude 80°, grass, willows and herbs grow abundantly enough to furnish pasture for numerous herds of such large herbivors as caribou and musk-oxen.

The most striking single feature of the Arctic is, perhaps, the absence of trees. There are small numbers of ligneous or woody plants—such as willows, ground birch and various kinds of berry bushes and heather. Even these, however, become low and dwarfed north of the tree line and are generally restricted to places where protecting snow cover is assured during the winter. On the mainland, some distance from the seashore, some of these species still form the dominating feature of the vegetation, but when we cross to the Arctic Islands their numbers rapidly dwindle. The willows here become low and trailing and the berry bushes disappear entirely. On the southernmost islands of the Canadian Arctic Archipelago, a few of the berry bushes are still to be found; but they no longer produce fruits; and farther north they drop out entirely. On Melville Island, credited with a flora of 86 species of vascular plants, there are but two species of woody plants: the prostrate arctic willow (*Salix arctica*) and the equally widely distributed white heather (*Cassiope tetragona*).

Owing to the severity of the climate and the short growing season the rate of growth in arctic plants is very slow. Many species require a long period of years before they flower and fruit for the first time. This is especially true of woody plants. In the trailing stems, no thicker than a man's thumb, of juniper or Lapland rhododendron, no less than 400 annual rings have been counted.

In the Arctic the short growing season is compensated by the continuous daylight and by the consequent long and continuous periods of insolation. Many arctic plants are "long-day" plants; and when transplanted or grown from seed in lower latitudes, they flower poorly or not at all. Conversely, some "short-day" plants, native to temperate or tropical countries, do not flower or reproduce well if grown under glass in the arctic continuous daylight.

In polar regions, particularly in the central parts of large continents or islands, precipitation is very light, often totalling under seven inches for the year. The winter snowfall is light, and frequent gales sweep the snow off the level ground, exposing the plant cover to the detrimental drying effect of the wind. So light indeed is the rainfall during the growing season that were it not for the fact that the soil remains perpetually frozen a few inches below the surface (permafrost), thereby preventing the surface water from penetrating to depths beyond the reach of the plant roots most of the arctic zone would be a lifeless desert.

In the Arctic the vegetation, to be sure, is much affected by the severe conditions under which plants must grow. The shortness of the growing season, however, and the deficiency of soil and precipitation have a more marked effect, perhaps, on plant life

than has the relative lowness of the actual air temperature.

Because of the absorption of heat by the dark-coloured soil and its vegetation, the actual micro-climate in which arctic plants live—i.e., the temperature of the surface soil and the air surrounding the growing plant—may be as much as 25 or even 40 degrees F. higher than that of the air. In northern Greenland, in latitude 82° 29′, during the month of May when the air temperature at noon was 10° F., the Swedish botanist Thorild Wulff recorded a termperature of 38° F. among the dead leaves of a tuft of saxifrage and 50° F. inside a cushion of dark coloured mosses. Here, then, we have the answer to the apparent enigma: How can plants in the Arctic grow and flower at air temperatures barely above freezing? Because of insolation, temperatures high enough for photosynthesis may actually exist near the ground or within the plant cushion when the air temperature a few feet above the ground is several degrees below freezing. During periods of unfavourable weather the growing parts of the plant may freeze but are not destroyed. In this manner the effective growing season of arctic plants is prolonged very considerably beyond the short period of days "without freezing temperatures" as recorded by the meteorologist. As yet plant physiologists have not been able to explain how, during the growing season, the cell protoplasm of arctic and alpine plants is able to survive the alternate freezing and thawing which would instantly kill plants of temperate climates.

Plant life in the polar regions, in a good many respects, resembles that found in the alpine regions of high mountains of more southern latitudes, and several life-forms and a great many species are common to the arctic zone and to Cordilleran peaks more than a thousand miles to the south. The principal physical difference is in the length of the growing season. But even this is actually more apparent than real, for in high mountains, the accumulation of snow is often so great that the length of the effective growing season closely approaches that of the Arctic. Thus, above timberline at Banff in the Canadian Rockies, in latitude 52° North, the collecting season for the botanist is approximately from July 1 to August 15. This period closely corresponds to that of the somewhat lower mountains west of the Mackenzie Delta, 16 degrees of latitude north of Banff, and, indeed, to the collecting season for most of the Arctic.

Owing to poor drainage and poor aeration—both partly due to the low temperatures—arctic and subarctic soils are generally acid. For the same reasons organic decay by bacterial action is extremely slow, and consequently the sources of available nitrogen, as well as other salts needed by plants, are frequently deficient. In a few places in the Arctic—such as bird cliffs, animal burrows and refuse heaps near human habitations—where nitrogen and phosphate are supplied, many arctic plants respond by lush and rank growth. Everywhere within the arctic zone, the subsoil is permanently frozen often to great depths. The annual thaw of the surface soil varies with its texture; in sand and gravel it may penetrate eight feet; in wet, peaty soil, permafrost may appear a few inches below the surface.

Characteristic of the level tundra is stagnant water that results from the presence of permafrost and consequent poor drainage. For about a month each spring, the tundra is very wet because of the melt water. Frost action here causes the formation of a characteristic network of more or less polygonal cracks, somewhat like, but on a much larger scale than, the cracks of dried-up mud or clay in the bottom of a summer-dry pond. As a result of the frozen soil the cracks and fissures remain water filled throughout the summer. The sedge-covered, peaty hummocks or tussocks—in Alaska and Yukon known as "niggerheads"—so characteristic of mature tundra are, in part, caused by frost cracks and frost heaving.

In loose stony soil mixed with clay, frost action causes a churning movement. This again causes a curious sorting of soil particles that results in the formation of stone rings, soil polygons and, on sloping ground, stone and soil creep (solifluction).

Structure, Habit and Dispersal of Arctic Plants

It is in adaptation to the short, arctic summer that almost all truly arctic plants are perennial. Summer is too short for annual species to complete a life cycle in one season.

Low, coastal flats east of the Mackenzie Delta photographed from 8,000 feet altitude.

R.C.A.F. photograph

Labrador tea (Ledum groenlandicum), *ubiquitous in wet tundra and muskegs.*

Alluvial flat on Coats Island.

Willow (Salix Richardsonii) *gone to seed on the shore of ice-covered Great Bear Lake.*

The failure of a single seed crop might exterminate the species in a local population. Most species require many years from germination to the first flowering. Many do not depend entirely on seed production for their propagation but are protected against unfavourable seasons by various means of vegetative reproduction.

In the Arctic there are neither climbing plants, plants that sting or poison, nor any that are protected by spines or thorns. The implication, of course, is that such protection is not needed. Many arctic plants are xerophytes: plants adapted to withstand prolonged drought by having rather small, often leathery leaves or by having their leaves and stems covered by densely matted hairs that provide a felt-like covering for the stomata.

Arctic plants exhibit a truly remarkable hardiness. On April 23, 1928, when the writer was camped in Dease Valley east of Great Bear Lake, a Chinook wind caused the temperature to rise in a few hours from –30° F. to several degrees above freezing. Sixty hours later the water began to run in the creeks and the buds to swell on a clump of Richardson's willow (*Salix Richardsonii*) behind the tent. The lower part of these six-foot willows was buried in three feet of ice and snow, but, nevertheless, the sap started to run in the parts protruding through the snow. After a week of thawing weather, the catkins were ready to expand. Then winter again set in, with temperatures down to zero. The willows, of course, froze solid and were covered with hoar frost. The large buds, and even the smaller twigs, broke off like icicles at the slightest touch. The cold spell lasted nineteen days. When the site was visited again three weeks later, the snow was thawing rapidly. The willows had suffered but slightly. Some buds had been broken off, most likely during a gale that had blown for three days, but the rest resumed their flowering process apparently unaffected. The male catkins were fully expanded a few days later, and the females followed after an interlude of a few days. The leaves succeeded the flowers that a month later produced abundant and ripe seed. One night late in July, 1944, when the temperature had dropped to 26° F., the writer found masses of the broad-leaved willow herb (*Epilobium latifolium*) in full bloom on a flood plain in a Yukon mountain pass. At 4 a.m. the petals and even the leaves were frozen as stiff as wax flowers and were covered with tiny ice crystals. A few hours later, when the sun rose over the mountain range, the flowers thawed and showed not the slightest sign of frost damage.

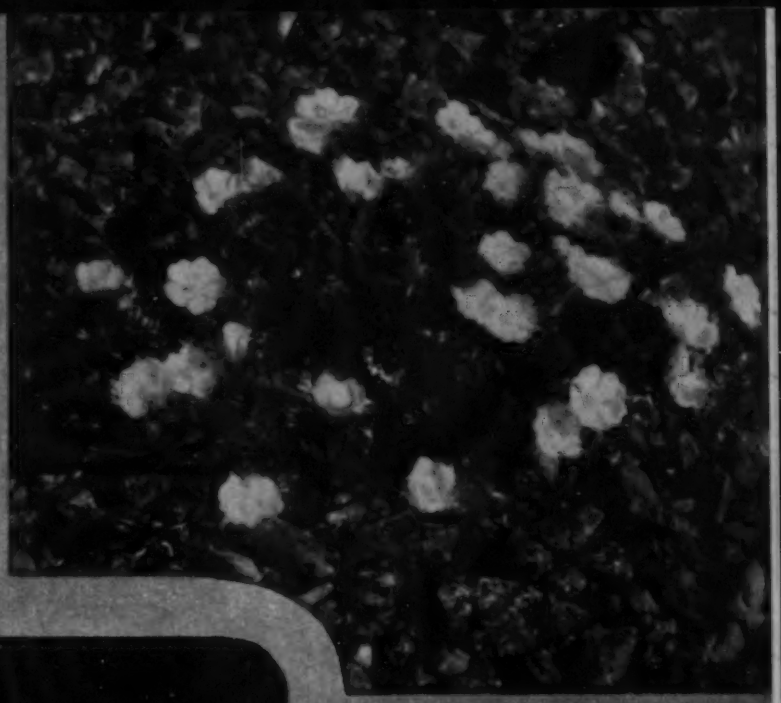
By their low and compact growth habit (cushion plants), arctic plants are well adapted to resist desiccation and mechanical abrasion by wind and by drifting snow and sand. As protection against desiccation rather than low temperatures, the wintering buds of many arctic plants are placed just below the surface of the soil (hemicryptophytes), or just above the surface where they are protected by the persisting leaves, leafstalks or stipules of former years (chamaephytes). Vegetative propagation is widespread and takes place in a number of ways: by adventitious buds in the leaf-axils (*Stellaria Edwardsii*), by turions or offsets (*Saxifraga flagellaris* and *Epilobium palustre*) and by bulbils (*Polygonum viviparum* and *Saxifraga cernua*) that become detached from the mother plant. Other species have widely creeping rootstocks or form adventitious roots and buds. Because of widespread vegetative or asexual reproduction among arctic

Arctic cotton grass (Eriophorum callitrix)*by a tundra pond.*

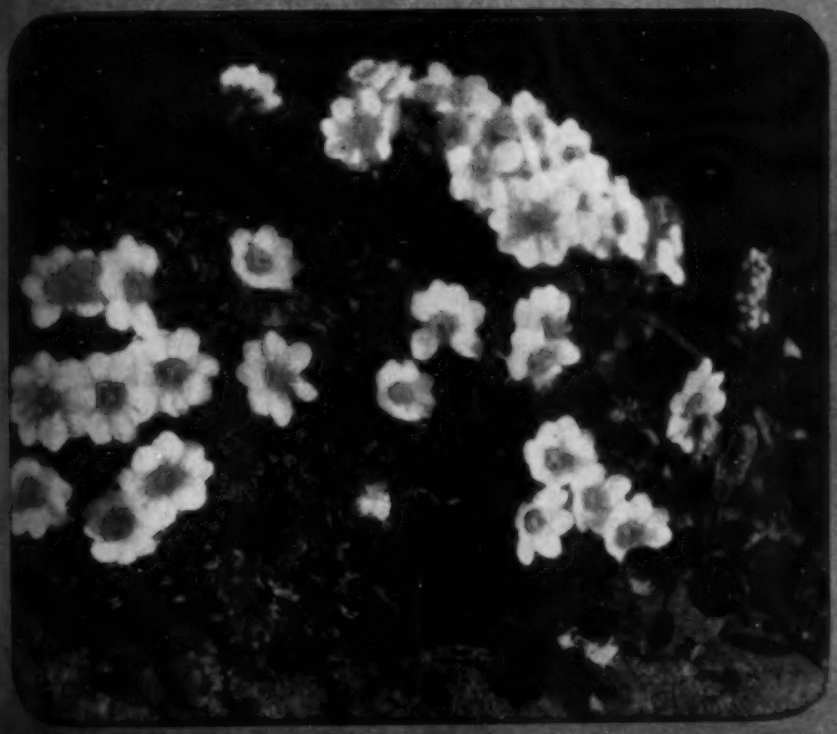
Left:—Miniature "rock garden" (on a south facing slope) near Cape Lambton on Banks Island. In foreground yellow Arnica alpina, *white prickly* Saxifraga tricuspidata *and the sweet-scented fern* Dryopteris fragrans.

Right:—Yellow arnica (Arnica alpina) *and scented shield fern* (Dryopteris fragrans) *with a back-drop of lichen-covered rocks.*

Left — Pink-spiked fernweed (Pedicularis arctica) *grows in moist tundra. Its yellow, fleshy root is edible and tastes like young carrot.*



Right:—Bright-flowered cushions of yellow cinquefoil (Potentilla rubricaulis) *appear to thrive on sterile gravel flats on Banks Island.*



Left: — Masses of creamy-white mountain avens (Dryas integrifolia) *for a short time each spring brightens the arctic rock desert.*

Right: — Small, purple-flowered saxifrage (Saxifraga oppositifolia) *grows at the northern tip of Ellesmere Island, 400 miles from the North Pole, and also at Gaspe, Que.*

plants, small variations in the form and structure often are remarkably stable.

In common with some desert plants, also adapted to a short growing season, many arctic species, thanks to their wintering buds, require a remarkably short time to awaken from winter dormancy, come to bloom, mature fruits and prepare again for next winter. The small, purple-flowered saxifrage (*Saxifraga oppositifolia*), the yellow whitlow grass (*Draba alpina*) and the yellow arctic poppy (*Papaver radicatum*) require only a month to commence growth, to flower and to mature seed.[1]

Spring comes with a rush in the Arctic. The snow disappears almost overnight; and long before the last drifts have entirely vanished, the first flowers put in an appearance. At the mouth of the Mackenzie Delta, the Pasque-flower or "wild crocus" (*Pulsatilla ludoviciana*) began growth on May 15, when a thin crust of snow still covered last year's withered leaves. On May 25, when the ground had dried, the large bluish flowers appeared while the new foliage was still undeveloped. On June 25 some of the seeds had already been dropped.

Early in August most of the arctic plants have completed their seasonal life cycle. While the seeds are maturing, new leaf buds and flower buds develop near the surface of the soil, well hidden among the dead leaves, and food is stored up in the subterranean stem or rhizome or in the root system, in preparation for next season's growth.

An important factor of plant migration is that solid ice in winter bridges not only lakes and rivers but, in some parts of the Arctic, also very considerable expanses of sea—particularly, straits and sounds separating

Pulsatilla ludoviciana, *the blue "wild crocus" of the Northwest.*

islands. It is also important that drifting snow each winter levels rough spots on the sea ice and on the land surface, thereby facilitating the transportation of seed by the wind. By this mode of transport, many species of arctic plants are able to travel very considerable distances and to cross bodies of water that would otherwise be barriers to migration. It is significant that a high percentage of arctic plants have relatively small and light seeds and that many are specially adapted or equipped for wind transportation. Another factor aiding in ease of migration is that winds of high velocity are more common in the Arctic than elsewhere.

Many species of arctic plants actually depend on wind dispersal in winter. In some of these the capsules do not mature and dehisce until after the snow covers the ground. It is common, moreover, for these to have stiff and erect fruiting stalks protruding through the snow throughout the winter; and the seeds of these plants may often be observed in the drifting snow. In places where large snowdrifts accumulate during winter—as on the lee side of large rocks or mountains—very considerable deposits of wind-transported inorganic dust or loess mixed with plant remains, including seeds, may be seen in spring when the snow melts. The accumulation of fertile soil found on many screes and slopes, where huge snowdrifts form (snowflushes), is deposited in this manner.

Water transportation by rivers and streams, and particularly by melt water in spring, is important. Each spring during the break-up, the north flowing rivers of continental parts of the North American Arctic are loaded with driftwood and flotsam composed in part of plant remains and seeds that have accumulated on the ice of lakes and rivers during winter.

Ocean currents undoubtedly are responsible for the transportation and dispersal of many sea-shore plants. As regards other species, however, the currents are perhaps not such important dispersal agents in the Arctic as has sometimes been assumed. The role of drift ice and drift logs as carriers is probably insignificant. The ability of birds to carry seeds has been much disputed. Long-distance transportation by birds may be unimportant, but there can be little doubt that birds are important agents in the "step-by-step" dispersal of plants. Over a long period of years certain species may migrate in this manner. This mode of transportation may explain the remarkably wide range of many aquatic plants that, in some places in the Arctic, are at present unable to reproduce by seeds.

At any rate we know that endozoic and epizoic "step-by-step" dispersal of plants is effected by a number of arctic mammals—chiefly the widely distributed ground squirrel (*Citellus*) and smaller microtine species, such as lemmings and field mice—which feed on and store seeds of a number of species of plants. They are capable also of carrying seeds which adhere to their fur. The burrows of ground squirrels and the dens of foxes and wolves are favourite habitats for such species as the forget-me-not (*Myosotis alpestris*), alpine foxtail (*Alopecurus alpinus*), Jacobs ladder (*Polemonium boreale*), Parry's wall-flower (*Erysimum Pallasii*), *Arabis Hookeri*, and others. Foxes, ptarmigans, ravens, sea gulls and geese feed on several species of berries and thus disperse the seeds endozoically (*Empetrum*, *Rubus Chamaemorus*, *Vaccinium spp.*).

Extent of the Arctic Habitat in North America

The arctic zone in North America comprises the Arctic Archipelago and, on the continent, all the treeless country lying north of the transcontinental coniferous forest. The southern boundary of the arctic zone, which thus coincides with the timberline, is not a straight line. It is affected to a far greater degree by physiographic features than by absolute geographical latitude. In Alaska, the boundary starts near the Yukon Delta in latitude 61°, then extends north along the shore of Bering Strait, which it approaches in several places where, on the larger rivers, the forest almost reaches the coast. In northern Alaska the arctic zone includes the north slope of the Brooks Range and the coastal plain. It narrows again at the mouth of the Mackenzie River, where the forest extends almost to latitude 69°. From the Mackenzie Delta the tree line runs in a southeasterly direction north and east of Great Bear Lake and reaches the west shore of Hudson Bay at Churchill, just south of

The "barren grounds" between Great Bear Lake and the Arctic coast.

latitude 60°. South of Churchill a narrow strip of land along the southwest shore of Hudson Bay may be termed arctic. Along the east shore, on the other hand, the forest extends north as far as Richmond Gulf. Thence the tree line cuts across northern Ungava but again is deflected southwards along the Labrador Coast.

Greenland, still in the ice age, is generally considered as being wholly within the arctic zone. Except for small areas near the southern tip, it belongs here, climatically speaking. Floristically, however, a comparatively large element in its flora is boreal or subarctic rather than arctic.

In North America the arctic zone is sometimes referred to as the "barren grounds" from the fact that it is treeless. In Eurasia the "barren grounds" are known as "tundra" from the Finnish word "tundren" meaning treeless rolling plain. As previously stated, the southern boundary of the arctic zone has been taken more or less conventionally to be the northern limit of trees, and it has been found that this roughly coincides with the course of the 50° F. isotherm for the warmest month of the year. A more accurate expression for the mean temperature of the warmest month required for tree growth has been given by Vahl's formula

$$v = 9.5 - \frac{1}{30}\,k$$

where v represents the temperature of the warmest month in centigrade and k that of the coldest month. This formula has been modified by O. Nordenskjöld[2] to read

$$v = 9° - 0.1\,k$$

This signifies that if the mean for the coldest month is −10° C. that for the warmest month will have to be +10° C. to permit forest growth; and further, that if in the centre of a continent the mean temperature of the coldest month sinks to −40° C., the mean for the warmest month must rise to +13° C. before the region can be included in the temperate belt.

Actually a number of other factors complicate the problem, and neither formula applies under all conditions. Thus, certain treeless oceanic islands are sometimes included in the arctic zone, although the species that dominate their floras are not truly arctic (Aleutian Islands). Conversely, in central

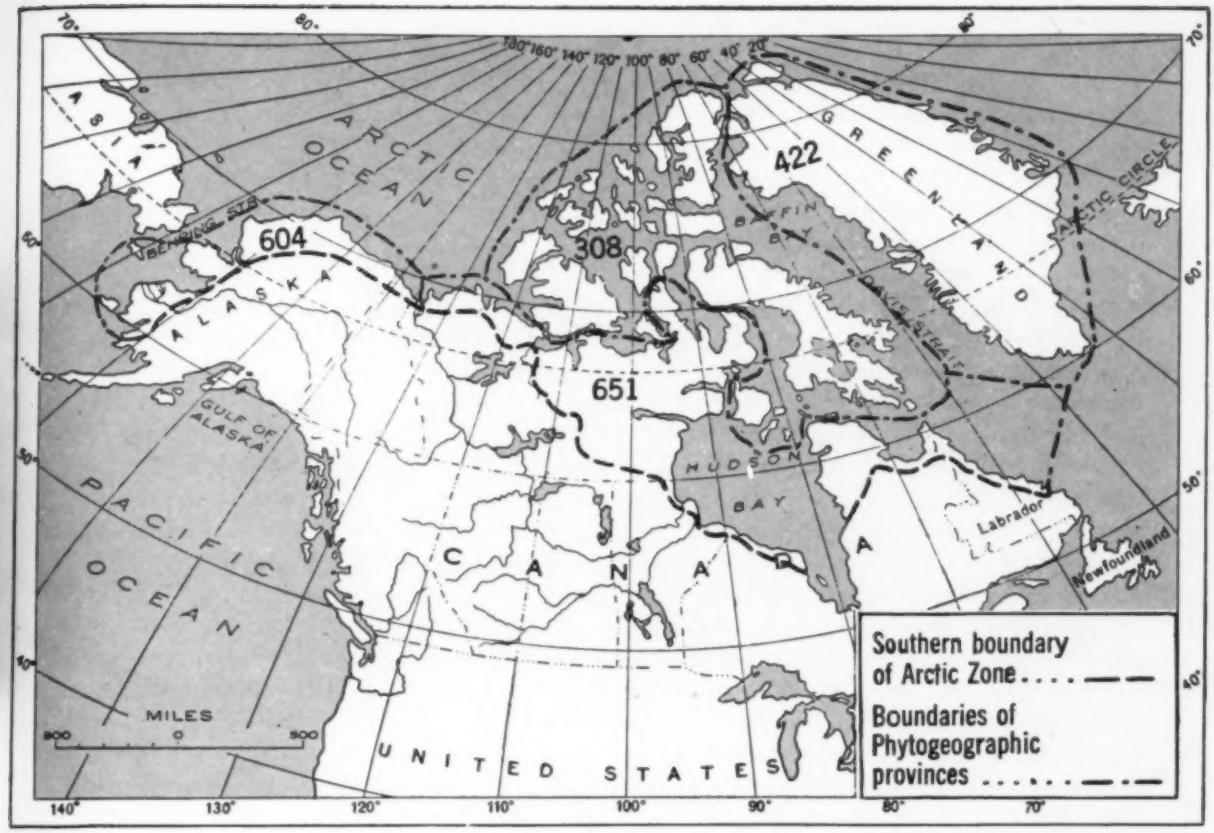


Fig. 1

Keewatin, large parts of the "barren grounds" are treeless not because of an insufficient summer temperature but more likely because of insufficient precipitation during summer, coupled with high frequency of winds and extreme dryness of the air during winter. Although the soil below the turf is perpetually frozen, these treeless plains may have the appearance of true grassland and are sometimes referred to as "subpolar meadows" or "arctic prairie".

Botany of the Arctic Landscape

Land surfaces in the Arctic may be said to provide three principal types of landscapes: (1) the ice desert, (2) the rock desert and (3) the tundra. The ice desert—which occupies 86 per cent of the interior of Greenland and some smaller mountain regions in Baffin and Ellsmere Islands—harbours, near its margins, a flora of plant organisms consisting of red and green algae (red snow), desmids and diatoms. The rock desert—the

Fell-field on Coats Island, Hudson Strait.

dominant landscape in heavily glaciated northeastern Keewatin and the Arctic Islands—is interspersed with lakes and ponds and smaller or larger areas of tundra. The tundra occupies a wide belt between the edge of the forest and the high arctic rock desert and is endowed with the richest flora. Like the rock desert it may be subdivided into several plant communities such as marsh, grassland, bogs and heath.

Consideration is given here only to the vascular flora. The cryptogamic flora of the arctic landscape is still very incompletely known outside of Greenland, and its ecological aspects are still less known. Perhaps the marine algae, as a group, are of most importance; next are the bryophytes and lichens, both very significant ecologically in the composition of arctic vegetation. Of special interest but of little importance is the flora of ice and snow. This is best known as "red snow" but is not as spectacular as is popularly believed. The red colour is caused by the minute spherical red and green algae, *Sphaerella* (*Chlamydomonas*) *nivalis* and *S. lateritia* and by the desmid, *Ancylonema Nordenskioldii*. In addition, other species of algae and desmidiaceous plants inhabit snow fields that persist throughout the summer and also the surfaces of glaciers and sea ice.

Comparatively little progress has been made in the study of plant communities in the North American Arctic. In the glaciated parts, at least, where the flora and the vegetation is young, many plant communities are as yet unstable. In unglaciated Alaska, however, a climax condition undoubtedly has been attained in the "niggerhead" tundra, which is so characteristic of the coastal plain landscape.

Four major groups of plant communities may be recognized in Arctic North America, each capable of subdivision into a number of more or less distinct associations of species, the relative importance of which again depends on the landscape.

(1) Rock desert or fell-field communities:
  (a) Rock desert.
  (b) Unstable screes and stone creeps.
  (c) Gravelly river flats and fans.
(2) Tundra communities:
  (a) Dwarf-shrub heath.
  (b) Lichen and moss heath.
  (c) Grassland.
  (d) Willow and alder thickets.
  (e) Marsh and wet tundra.
  (f) Snowflushes.
(3) Strand communities:
  (a) Lagoon and salt marsh subject to floods.
  (b) Sand dunes and gravel beaches.
  (c) Rocky shores.
(4) Vegetation of fresh waters:
  (a) Ponds and lakes.
  (b) Brooks and rivers.

(1) Rock desert communities

The fell-field or rocky barrens have been defined[3] as having so scanty a vegetation that the substratum is never completely covered by vegetation. It is found at high elevations as well as in high latitudes and occupies the greater part of the Arctic Archipelago and the highest mountains.

Rock desert on Baffin Island. J. D. Soper

The purple flowers of broad-leaved willow herb (Epilobium latifolium).

(a) Most striking in the rock desert landscape are the flat rock tables and ridges of Precambrian, crystalline rocks of the heavily glaciated Canadian Shield or peneplain that has been left almost completely denuded of soil, and the extensive flat or slightly rolling, rock-strewn plateaus of weathered Paleozoic or Precambrian sedimentary rocks of the western and northern islands of the Arctic Archipelago. But even these are not entirely devoid of vegetation; the rock surface of the acid Precambrian rocks is covered by black, brown and grey species of crustaceous lichens (*Rhizocarpon*, *Lecidea*, *Lecanora*, *Buellia* and others) or by the large, black foliose lichens, called "rock tripe", (*Gyrophora* and *Umbilicaria*) that all lend a sombre and rather depressing hue to the landscape. On loose rock and gravel grow a number of fruticose species, among which may be mentioned the coral-like *Stereocaulon*, black and grey *Alectoria* and yellow, grey or brown species of *Cetraria* and *Cladonia*. Where isolated boulders provide a perching place for snowy owls, hawks and other birds, the dung-loving orange or vermilion lichen (*Caloplaca elegans*) often grows in profusion.

Rocky-strewn barren flats of weathered Paleozoic rocks that from the air may look entirely devoid of vegetation, on closer inspection from the ground may reveal extensive colonies, often arranged in "islands" or stripes, of mountain avens (*Dryas integrifolia*) or loco-weed (*Oxytropis arctica* and *O. arctobia*). For a short time each season these flowers transform the dreary rock desert to incredibly gay "rock gardens".

The plants that grow on wind-swept stony soil develop dense tussocks or flat hemispherical cushions, the shape of which provides protection against evaporation and mechanical abrasion by wind and drifting sand or snow. Other examples of such plants are the moss pink (*Silene acaulis*), *Draba Bellii*, *Saxifraga caespitosa*, *S. tricuspidata*, arctic poppy (*Papaver radicatum*), the cotton grass (*Eriophorum vaginatum*) and many other sedges and grasses. In crevices grow a number of species of rock plants, among which saxifrages, sedges and grasses (*Festuca brachyphylla*, *Carex rupestris*) dominate. In such places we also find three ferns: the tiny, delicate *Woodsia glabella*, *W. ilvensis* and the sweet-scented shield fern (*Dryopteris fragrans*). On rocky slopes where some soil has accumulated, the showy white-flowered avens (*Dryas*) often abounds. It forms large, flat cushions, often many feet in diameter, which sometimes exclude other species. With it may grow large mats of crowberry (*Empetrum*), clumps of the purple-flowered, broad-leaved *Epilobium latifolium* or *Hedysarum Mackenzii*, whose showy purple flowers are scented like sweet clover. Other colours are added by the lilac-flowered vetch, *Astragalus alpinus*, yellow arnicas and loco-weed (*Oxytropis*), by blue campanulas and white chickweeds (*Stellaria* and *Cerastium*) or by the large-flowered and very fragrant *Pyrola grandiflora*. In southern parts of the Arctic the rock desert is inhabited also by a number of dwarf shrubs, the chief of which are willows and various species of heath and *Vaccinium*. These are always low or even prostrate, with their branches bent and gnarled. The whole plant may be contorted by the wind, so that its prostrate crown grows away from its root, like a ship riding at anchor. Willow and ground birch often grow espalier-like against a south-facing rock or cliff, where they obtain added heat when the sun warms the rock. The roots of these dwarf trees or shrubs run horizontally in the upper layers of the soil, avoiding the permafrost. The majority are evergreen, and the structure of their leaves possesses special features, such as hair covering and concealed stomata which prevent dehydration.

(b) Unstable screes and stone creeps, polygon fields, etc., are essentially alpine formations but they are common also at lower elevations, where they are confined mainly

Dwarf shrub heath west of the Mackenzie Delta.

to the rapidly weathering rocks in the Paleozoic areas of the Arctic Archipelago and to the proximity of glaciers. The unstable soil conditions of these habitats make them unsuitable for many species. Plants with woody stems or those having horizontal rhizomes are particularly at a disadvantage, whereas those with runners, strongly developed taproots or adventitious root systems are able to persist.

(c) Gravelly river flats and fans, characterized by unstable and frequently flooded soil, are inhabited by a group of plants whose growth form, as in the case of the scree plants, particularly suits them to such conditions. The predominance of alpine or truly arctic species in these unstable low-land habitats has sometimes been taken to indicate that these plants were washed down from adjacent mountains by glacial torrents during spring freshets and that they are able to gain a foothold because of the absence of competition. Perhaps the primary reason arctic and alpine plants dominate such habitats is that during winter the river beds and flood plains accumulate huge masses of ice (*Aufeis*) that persist until late into the summer, thereby shortening the season to such an extent that only truly arctic plants can survive here.

(2) Tundra communities

The tundra differs from the rock desert in having a closed or continuous cover of vegetation and in having a protecting snow cover in winter.

(a) The dwarf-shrub heath tundra attains its greatest luxuriance in a continental climate and is best developed on the interior coastal plains of Northern Alaska at some distance from the sea, on the mainland north of Great Bear Lake, in central Keewatin and in Greenland fiord districts. It is essentially a lowland plant community and has its counterpart in the muskeg of the boreal forest. Its chief components are ground birch (*Betula glandulosa*), Labrador tea (*Ledum decumbens*), purple Lapland rhododendron (*Rhododendron lapponicum*), bear berry (*Arctostaphylos alpina* and *A. rubra*), white heather (*Cassiope tetragona*), bilberry (*Vaccinium uliginosum*) and the alpine cranberry (*Vaccinium Vitis-Idaea*). Ubiquitous also are sedges and grasses—notably cotton grass (*Eriophorum vaginatum* and *E. spissum*) which form tussocks that are known in the north as "nigger-heads" or "têtes de femmes". Among the small number of herbaceous plants, fern-weeds (*Pedicularis labradorica*, *P. sudetica*, *P. lanata*) and, in the west, the beautiful blue-spiked lupin (*Lupinus arcticus*) are the most showy. For a short time in early summer the heath is gay with colour, but for the rest of the year it presents a dreary aspect.

The ground under and between the stems of the dwarf bushes is everywhere covered by a thick carpet of mesophytic lichens and mosses into which the foot of the traveller sinks ankle deep at every step, making travelling on foot exceedingly wearisome.

(b) Lichen and moss heath. In drier and better drained parts of the tundra the dwarf-shrub heath imperceptibly passes into lichen and moss heath. The mesophytic species of mosses give way to grey and brown fruticose lichens of which the so-called reindeer mosses (*Cladonia rangiferina*, *C. alpestris*, *Cetraria nivalis*) and Iceland moss (*Cetraria islandica*)

dominate to such an extent that the landscape may appear as if snow covered. In time, most herbs and low dwarf shrubs become submerged in the lichen carpet, and only ground birch, rhododendron and willow remain.

(c) Extensive grassland is found in several places in the arctic tundra. In central Keewatin it occupies alluvial flats formerly occupied by large glacial lakes. There is reason to believe that the grassland, in time, will be invaded by tundra shrubs and eventually change to dwarf-shrub heath.

(d) Willow and alder thickets, with their accompanying flora of herbaceous species, are found chiefly in the tundra of the continent along streams, south-facing slopes and on the steep shores of lakes, where protection against wind and consequent accumulation of snow is assured. The principal thicket-forming willows are *Salix arbusculoides*, *S. pulchra*, *S. Richardsonii*, *S. glauca*, *S. planifolia*, and *S. alaxensis*. The last mentioned may occasionally assume a tree-like growth, whereas the rest are bushlike and rarely exceed eight feet in height. The alder (*Alnus crispa*) does not extend far north of the tree line. Characteristic herbs growing in the thickets are fire weed (*Epilobium angustifolium*), horsetail (*Equisetum spp.*), the buttercup (*Ranunculus lapponicus*), white anemone (*Anemone parviflora*), *Petasites frigidus*, *Senecio lugens* and a number of sedges and grasses. Of the latter, cotton grass (*Eriophorum angustifolium*), blue-joint (*Calamagrostis canadensis*) and *Arctagrostis arundinacea* are the most important. Willow thickets require an abundant water supply during the summer.

(e) Marsh and wet tundra are predomin-

Blue-spiked lupin (Lupinus arcticus) *common in the mountains of Yukon and on the Arctic coast.*

Arctic short-grass prairie in central Keewatin.

ant on low coastal flats of the unglaciated arctic coast of Alaska and are probably climax types found on thick deposits of raw humus or peat overlying fossil ice. The drainage is poor, and in spring, soon after the snow has disappeared, the tundra is inundated by melt water above which only the "niggerheads" emerge. Sedges and grasses make up the bulk of the species, with willow and ground birch as the principal woody components.

(f) Snowflush herb mats are best developed in the tundra of mountain country, where the accumulation of large snow drifts during winter is favoured by high winds and heavy snowfall. In the lowland, large drifts favourable for the formation of this kind of vegetation may be found in river valleys, on sheltered slopes and on lake-shores. The principal difference between the willow thicket and snowflush vegetation is conditioned by the duration of the snow drifts: too deep a snow drift shortens the season too much for willows. For this reason willow thickets usually are found on the outer margins of snowflushes, thus giving the impression that the willows are invading the snowflush areas. Snowflush vegetation consists almost entirely of herbaceous species, chiefly of the hemicryptophytic type. The tiny willows (*Salix herbacea*) in the east, and (*S. pseudopolaris*) in the west are among the few woody plants found here. Characteristic of snowflush plants is their ability to persist vegetatively for several seasons when thick snow drifts reduce their growing season to a minimum. Many snowflush plants may not flower and fruit for a period of years. Whereas the aspect of snowflush vegetation is essentially alike everywhere the floristic composition varies greatly according to its geographical position. For example, snowflushes in Greenland and in the Mackenzie Delta have almost no species in common.

Tundra along the Kazan River in central Keewatin.

Examples of widely distributed snowflush plants are the sedge (*Carex scirpoidela*), mountain sorrel (*Oxyria digyna*) the dwarf buttercup (*Ranunculus pygmaeus*) and alpine clubmoss ((*Lycopodium alpinum*).

(3) Strand communities

(a) Lagoons and salt marshes subject to floods are found chiefly on the low continental alluvial coast flats of northern and western Alaska. They extend east of the Mackenzie to the Anderson River. Large shallow and brackish bays are here cut off from the open sea by long sandspits or by narrow sand or gravel islands. Rivers emptying into the lagoons speed up the silting process, which is further favoured by the almost negligible tide. Characteristic in wet places are the grasses (*Arctophila fulva*, *Dupontia Fisheri*, *Puccinellia phyganodes*) and a number of sedges and the cotton grasses (*Eriophorum angustifolium* and *E. Scheuchzeri*). A few marsh herbs grow here, among them the sweet-scented white buttercup (*Ranunculus Pallasii*), *Caltha natans* and a few others. Rushes (*Juncus balticus and J. castaneus*), with *Stellaria humifusa* and *Puccinellia spp.* may dominate in somewhat drier places.

(b) Of the strand vegetation of sand dunes and gravel beaches, lyme grass (*Elymus*) is almost never absent on dunes except in the highest latitudes. With it grow a number of other grasses—chiefly poas, fescues and brome grass (*Bromus Pumpellianus*), together with a few halophytic sedges, beach sand-wort (*Arenaria peploides*) and a few species of willow.

(c) Characteristic strand vegetation of rocky shores that are not too exposed to the open sea are dense swards of *Puccinellia phryganodes* and similar grasses that occupy crevices and interstices between rocks. Here also grow the scurvy grass (*Cochlearia*), *Stellaria humifusa* and a few other sea-shore plants.

(4) Vegetation of fresh waters

(a) Ponds and lakes. Nearly all large lakes in the Arctic are too cold for vascular aquatic plants, but they possess a rich flora of microorganisms such as green and blue-green algae, desmids, diatoms and flagellates. Different species of these mostly microscopic organisms often impart a distinctive colour to the waters of the lakes. This is best seen from the air, and it is at once noticeable that apart from the difference in colour, caused by the depth of the waters and the nature of the bottom, the water itself in no two lakes is exactly alike.

Small, shallow ponds that remain water filled throughout the summer, on the other hand, sustain a surprisingly rich plant life. Because of their shallowness and dark coloured bottom, the waters of these ponds warm up quickly and become free of ice long before the large lakes. The short season prevents many species of aquatic plants in the Arctic from reproducing by seed, but they maintain themselves successfully by the production of wintering buds (*Potamogeton spp.*, *Utricularia*, and others). The most common aquatic plants here are pond weeds (*Potamogeton*), *Ranunculus hyperboreus*, water buttercups of the *Batrachium* group and marestail, (*Hippuris vulgaris*). Floating or submerged mosses (*Hypnum spp.*) also are abundantly represented, as are fresh water algae.

(b) Brooks and rivers. Small, sluggish lowland streams in the Arctic may sometimes be inhabited by aquatic plants similar to those of freshwater ponds. Most streams, however, are too cold or too turbulent for vascular species. A number of marsh plants —chiefly sedges and grasses—inhabit protected places on stream margins and flood plains. A number of dark coloured mosses (*Grimmia spp.* and *Hygrohypnum*) and blue-green and brown algae grow on the rocks of most arctic brooks, even in water that is

Arctic white heather **(Cassiope tetragona).**

Arctic grass (Alopecurus alpinus).

but a few degrees above freezing. The brown, slimy flagellate (*Hydrurus foetidus*) flourishes on the rocks of clear pools in ice-cold melt water below snow fields.

The Arctic Flora in Relation to Man

Few plants native to the Arctic are of direct importance in the economy of man. None of the woody species are of a size large enough for constructional use by the Eskimo who, at least formerly, obtained what wood he needed chiefly from driftwood. Heather and berry bushes, stunted willows, alder and ground birch are used by the Eskimo for cooking purposes. Of greatest importance are crowberry (*Empetrum*) and the white heather (*Cassiope tetragona*) both found almost everywhere in the Arctic. The white heather is so rich in resin that it will burn even when moderately wet. Nearly all larger species of lichens—particularly species of *Cladonia* and *Cetraria*—are highly inflammable when dry and may be used for fuel. Raw peat, particularly heath turf, but also partly decomposed sphagnum moss, is available nearly everywhere in the Arctic and in Greenland provides an important source of fuel.

Indirectly the arctic vegetation is of great importance to man because nearly all sedges, grasses and fruticose lichens, in addition to many herbaceous and woody plants, furnish food for grazing animals. Seeds, winter buds and roots of many species are eaten by birds and small rodents that in turn constitute the food of some of the fur-bearing mammals. Likewise, the comparatively rich marine plant life indirectly furnishes food for the sea mammals so important in the economy of the Eskimo.

A small number of plants found in the Arctic are used for food by native and white inhabitants, [4,5]. Of greatest food value, perhaps, are the lichens, though none is used by natives. Species of the black and grey lichens known as "rock tripe"—chiefly *Umbilicaria* and *Gyrophora spp.*—grow on acid rocks throughout the Arctic. Together with a few of the fruticose species—chiefly, Iceland moss (*Cetraria islandica*) and reindeer moss (*Cladonia rangiferina* and *Cl. alpestris*)—they have been used regularly by arctic travellers, and on more than one occasion have saved the lives of field parties. Numerous species of edible fleshy fungi (mushrooms) are found in the Arctic but are not used by natives. In Greenland and Baffin Island some green and red marine algae (dulce or sea-lettuce) are eaten by the natives in times of scarcity, and in Greenland the succulent young stalks of angelica (*Archangelica officinalis*) and the leaves of sorrel (*Oxyria digyna*) are highly prized. In Alaska the leaves of a saxifrage (*Saxifraga punctata*), dock (*Rumex spp.*) and the tubers of the Eskimo potato (*Claytonia tuberosa*) are commonly used. Several kinds of "berries"—including crowberry (*Empetrum*), cloudberry or baked-apple (*Rubus Chamaemorus*) and bog-bilberry (*Vaccinium uliginosum*), when available are used by all Eskimos.

Problems in Arctic Botany

The arctic flora in general is circumpolar. Many species are without even varietal geographical differentiation while others have developed more or less marked geographical subspecies or races.

The arctic flora is considered to be of ancient lineage. The existence of a number of species—which now have circumpolar distribution and which are identical with or closely related to fossil forms—strongly favours the assumption that the arctic flora must have persisted, much as we now know it, throughout the Ice Age. It was formerly thought that the arctic flora that occupied areas later to be invaded by the great continental ice sheets was destroyed or driven south by the advancing ice, later to return when the ice disappeared[6]. More recently

the hypothesis has been advanced that most arctic species were able to persist throughout the Pleistocene on unglaciated refugia within the arctic and subarctic regions[7, 8, 9].

Phytogeographically the North American Arctic may be divided into four rather distinct regions: (1) the arctic parts of Alaska and Yukon, (2) the arctic parts of Continental Northwest Territories and Ungava, (3) the Arctic Archipelago, and (4) Greenland. Of these, arctic Alaska and Yukon possess the most interesting and varied floras (604 species). The reason for this is that they were largely unglaciated and were connected, through the hypothetical and now submerged Beringia[8], to the rich floras of Asia. Alaska and Yukon are also connected with the north- and south-oriented Cordillera, which, in post-Pleistocene time, must have provided a "highway" for alpine and arctic species. Like the Cordillera, Alaska and Yukon are rich in endemic and isolated species indicative of the great age of their flora.

Notwithstanding the vast extent of the arctic zone in continental Northwest Territories and Ungava, the flora is very uniform (651 species). Partly, the reason for the uniformity is the absence of high mountain barriers and, partly, the uniformly dry continental character of the climate of the interior plains and low plateaus. Perhaps of equal significance is the fact that the flora here—compared with that of Alaska, Yukon and other parts of the North American continent—is very young because of its glacial history. Its comparative youth is indicated by unstable, pre-climax plant communities and by the fact that perhaps less than a dozen species of vascular plants are endemic to this region. It is significant also that comparatively few species of Asiatic or Cordilleran origin have had time to cross the Mackenzie Valley that now sharply divides the flora of the interior continental plain from that of Alaska-Yukon and the Pacific coast. On the other hand, in the total number of species of plants which have actually been recorded from the Continental Arctic is included a number of plants that should, properly, be classed as forest species. It is not clear whether these plants are at present invading the arctic zone, due to an amelioration of the climate, or if they are lingering survivors from a former milder climatic period.

The vascular flora of the Arctic Archipelago (308 species) is comparatively poor. This, of course, is natural, considering present climatic conditions and the fact that it is still very incompletely known. The presence of a relatively high number of endemics and some very curious distributional patterns make further botanical exploration highly desirable.

Although the flora of Greenland has been studied longer and more intensely than that of any other arctic country, it still presents some very puzzling and unexplained phytogeographical problems. Considering the vast extent of the Greenland coastline, from latitude 59° 46′ to 83° 39′, its flora (422 species of vascular plants) is not large. Furthermore, the small number of endemic or isolated species suggest that it, too, is relatively young.

Causes for the differing amounts of endemism in the various geographic areas of the Arctic are not clear. They constitute one of the most intriguing problems in arctic botany and must be considered in the light of the glacial and post-glacial history of the flora.

Our present knowledge of the lower forms of plant life in the Arctic is still very fragmentary, and it is not possible even to estimate their numbers with any degree of accuracy. Best known is the cryptogamic flora of Greenland and that of the Eastern

Eutrema Edwardsii *grows in wet tundra.*

The arctic poppy (Papaver radicatum) *is widely distributed. Flowers are usually yellow, sometimes white.*

Fat catkins of the creeping arctic willow (Salix arctica) *appear before the tundra is free of snow.*

Canadian Arctic. The following figures give the known numbers of species in some of the main groups of cryptogams from Greenland [10,11], with the corresponding number of species (in parenthesis) recorded from the Eastern Canadian Arctic[12]: Bryophytes 608 (382); lichens 285 (275); fungi 717 (79); marine and freshwater algae 544 (383); marine and freshwater phytoplankton and diatoms 658 (313).

Statistical treatment of the component phytogeographical elements in a given flora must necessarily be somewhat arbitrary because a number of factors—such as variation in species concepts, and the sorting of species into groups, etc.—in large measure rest upon individual judgment. Any tabulation, therefore, is at best an approximation. Because each new expedition to the Arctic will extend the known ranges of species, the known numbers of species are nearly always minima. But while the absolute numbers are thus subject to correction, the percentages, in relation to the total flora, are probably more or less constant. In the table they are shown in italics below the absolute figures.

The amphi-Atlantic species (Fig. 7 and 8) in the East may be compared with the Beringia radiants. As the name of the group implies, they occupy both sides of the Atlantic, and most of them Greenland and Iceland as well, but in North America they rarely extend west of Hudson Bay. As with the widely distributed species, their subdivisions into arctic and subarctic groups is more or less arbitrary. The combined groups comprise 28 per cent of the total flora of Greenland.

The least satisfactory major groups in the table, from the standpoint of statistical classification, include the endemic species. Many of these belong in largely parthogenetic (apomictic) genera—such as *Antennaria*, *Hieracium* and *Taraxacum*—and are able to produce seed without fertilization. In this manner, even minor mutants or variations are perpetuated, and when treated as "species" bulk unduly large in total numbers of species in a given region. These apomictic "species" are probably all relatively young, whereas another type—the relic endemics or isolated species, sometimes referred to as "senescent species"—probably are remnants of an ancient, once more widespread flora (Fig. 9).

Considering the problem of land connections with Europe and Asia, many present day plant geographers and geologists discount the possibility that land bridges connected Greenland to continental North America and to Europe through Iceland in post- or interglacial time. It is difficult, however, to account for the presence of such a large element of purely European species in the flora of arctic and boreal eastern North America without such post- or interglacial land connections. So far, plant geographers have been working almost entirely with recent and fossil plants and have largely ignored the present and past distribution of other forms of life—particularly, land and freshwater invertebrates. For example, the presence in the island of Greenland of sev-

eral species of earthworms and land snails needs to be explained as much as does the presence of wholly palearctic species of plants.

Let us now briefly consider the effects of Pleistocene glaciation on arctic floras. During the maximum advance of the Wisconsin ice sheet, Ungava and all of continental Northwest Territories, except a narrow fringe east of the Mackenzie Delta, were covered by a great thickness of ice, but the northern portion of the Arctic Archipelago may have escaped glaciation. Most of Alaska and central Yukon, likewise, was unglaciated, except for local glaciers in high mountains. In these unglaciated areas, plants must have been able to survive the glacial period that destroyed all plant life in the continental parts.

Central Greenland is covered by a thick ice cap; and only a coastal fringe, varying in breadth from a few miles to 160 miles, is free from ice. Here, then, conditions prevail today similar to those that existed near the edges of the Wisconsin ice sheet. The glacial history of Greenland is still imperfectly known, but it is certain that there have been several successive advances and retreats of the ice front, which again has resulted in a broadening and narrowing of the ice-free fringe; at any rate, the coastland of today —except for a few small unglaciated nunatak areas that protruded above the inland ice—was heavily glaciated during earlier maximum advances of the ice.

Following the Wisconsin glaciation, the present flora of Arctic and Subarctic North America must have migrated into the land surfaces exposed when the ice withdrew, and it must have come from adjacent unglaciated refugia where it had survived. Several interesting theories have been advanced concerning the origin and history of the present flora of the Arctic[6, 7, 8, 9, 13, 14, 15, 16, 17].

It must suffice here merely to point out that the problems are very complex and involve not only phytogeographical but also zoogeographical as well as geological problems. Together with a large, now submerged land area, which must have existed in the Bering Sea (Beringia), and with possibly smaller nunatak areas in the Cordillera, unglaciated Alaska and Yukon must have been the source of the present western element in the flora.[8] The great mass of widely distributed species in the arctic flora could have survived on mountains and lowlands adjacent to the ice, as, indeed, the present flora of Greenland most successfully does today, and at least some of the eastern and montane species must have survived in nunatak areas in the East. The post-glacial sources and development of the flora of any given area must be related to the physiographic development of its surfaces. Furthermore, the presence and behaviour of the species which compose the vegetation appear to be conditioned by the effects of the great ice caps upon their earlier populations. It has been proposed, for example, that the exces-

Bluish-white anemones (Anemone parviflora) *grow in turfy places in tundra and fell-field.*

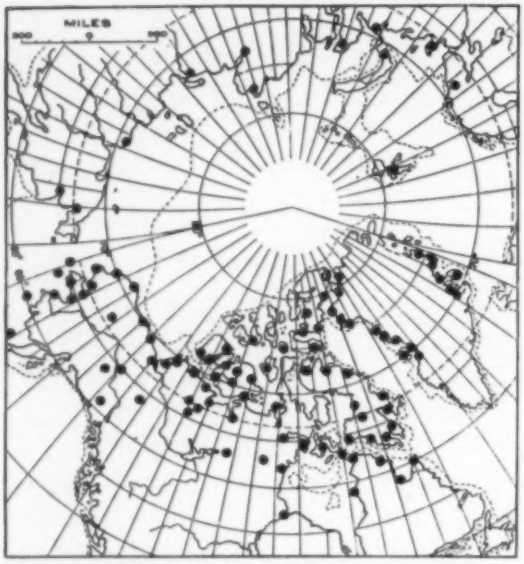


Fig. 2—Widely distributed (circumpolar) arctic species (112 species).

Total range of *Arctagrostis latifolia*. Examples of species with a similar distributional pattern are: *Equisetum variegatum, Lycopodium Selago, Agrostis borealis, Alopecurus alpinus, Eriophorum Scheuchzeri, Carex rariflora, Juncus biglumis, Oxyria digyna, Polygonum viviparum, Stellaria humifusa, Ranunculus pygmaeus, Eutrema Edwardsii, Saxifraga Hirculus, Astragalus alpinus, Empetrum nigrum, Epilobium latifolium, Campanula uniflora, Senecio congestus,* etc.

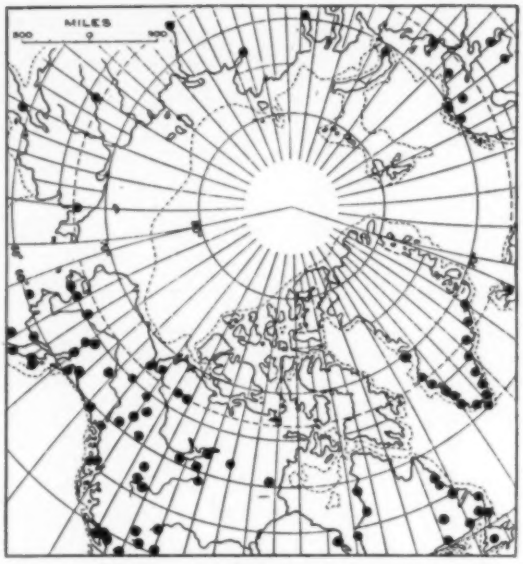


Fig. 3—Widely distributed (circumpolar) subarctic species (156 species).

Arctic and subarctic range of *Pyrola minor* (also in mountains of North America, Europe and Asia south of area shown). Examples of species with similar distributional pattern are: *Selaginella selaginoides, Triglochin palustre, Phleum alpinum, Poa alpina, Carex microglochin, Luzula spicata, Tofieldia palustris, Koenigia islandica, Ranunculus reptans, Drosera rotundifolia, Rubus Chamaemorus, Potentilla palustris, Hippuris vulgaris, Lomatogonium rotatum, Menyanthes trifoliata, Pinguicula vulgaris,* etc.

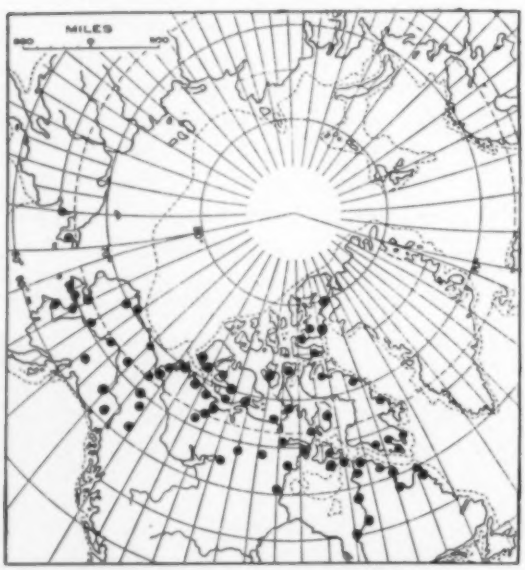


Fig. 4—North American species (28 arctic and 98 subarctic species).

Total range of *Carex membranacea*. Examples of species with similar range are: *Carex praticola, Salix Richardsonii, Anemone parviflora, A. Richardsonii, Lesquerella arctica, Saxifraga tricuspidata, Potentilla emarginata, Dryas integrifolia, Ledum groenlandicum, Gentiana propinqua, Erigeron compositus, Antennaria Ekmaniana,* etc.

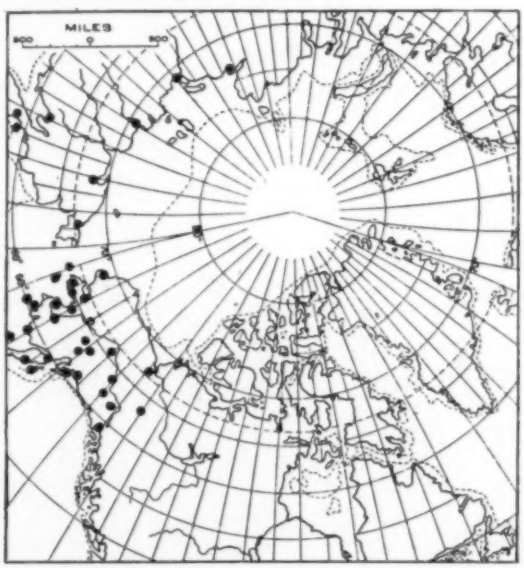


Fig. 5—Northern Beringia bilateral radiants (160 species).

Northern range of *Diapensia obovata* (also in mountains of Central Asia, west to Lake Baical and south to Japan). Examples of species with a similar distributional pattern are: *Carex nesophila, Salix alaxensis, S. phlebophylla, Claytonia sarmentosa, Arenaria arctica, Saxifraga serphyllifolia, Oxytropis Mertensiana, Conioselinum cnidiifolium, Gentiana algida, Polemonium acutiflorum, Lagotis Stelleri, Antennaria monocephala, Artemisia arctica,* etc.

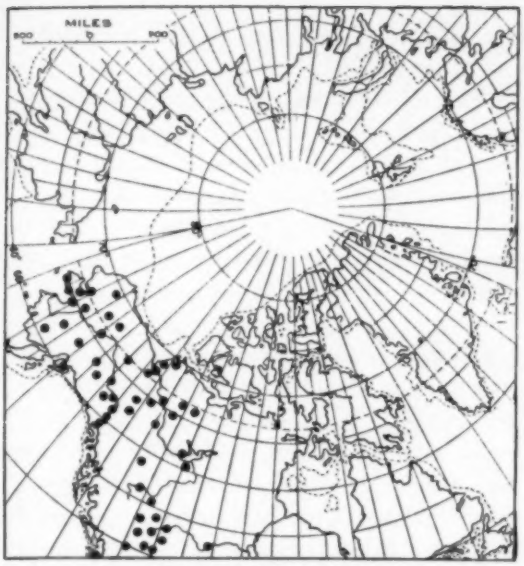


Fig. 6—Cordilleran radiants (39 species).

Northern range of *Zygadenus elegans* (south also to Minnesota, Nevada, Arizona and New Mexico). Examples of species with a similar range are: *Abies lasiocarpa, Carex petricosa, C. albo-nigra, Delphinium glaucum, Draba densifolia, Luetkea pectinata, Phyllodoce empetriformis, Polemonium pulcherrimum, Senecio lugens, S. triangularis,* etc.

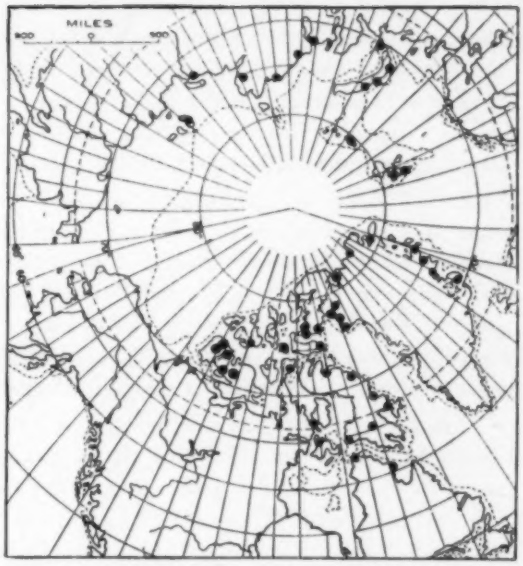


Fig. 7—Amphi-Atlantic arctic species (33 species).

Total range of *Pleuropogon Sabinei.* Examples of species with a similar distributional pattern are: *Deschampsia, brevifolia, Poa abbreviata, Puccinellia Vahliana, Carex nardina s.str., C. holostoma, Cerastium Regelii, Draba subcapitata, Potentilla pulchella, Cassiope hypnoides, Diapensia lapponica, Pedicularis hirsuta,* etc.

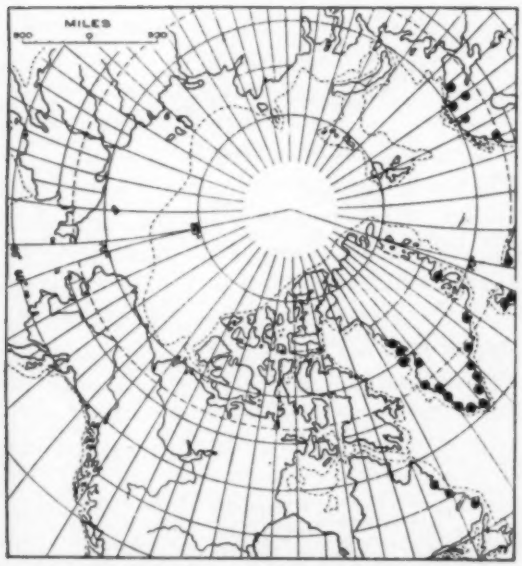


Fig. 8—Amphi-Atlantic sub-arctic species (84 species).

Sub-arctic range of *Gentiana nivalis* (also in mountains of Central Europe and Asia minor). Examples of species with a similar range are: *Calamagrostis hyperborea, Carex norvegica, C. saxatilis, Juncus arcticus, Salix herbacea, Betula nana, Rumex acetosella, Cerastium cerastioides, Viscaria alpina, Arabis alpina, Saxifraga Aizoon, S. stellaris, Potentilla maculata, Phyllodoce coerulea, Diapensia lapponica, Bartsia alpina, Gnaphalium norvegicum,* etc.

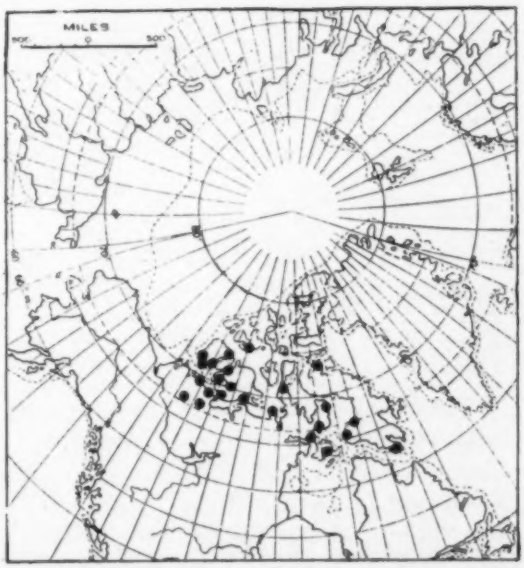


Fig. 9—Arctic Archipelago radiants (25 species).

Total range of *Oxytropis arctobia.* Examples of species with a similar distributional pattern are: *Kobresia hyperborea, Ranunculus Sabinei, Parrya arctica, Braya pilosa, Draba Bellii, Oxytropis arctica, Pedicularis arctica. Mertensia Drummondii, Aster pygmaea, Erigeron yukonensis, Artemisia hyperborea. Taraxacum hyparcticum, etc.*

sive depletion of some of these populations has caused some species to become "rigid" or "conservative" (depauperation of biotypes)—actually unable to migrate and adapt themselves to the new situations laid open by the retreat of the glaciers. At the same time, other species are thought to have maintained relatively large spreading capacity. There appear to be some genetical grounds for these suppositions[18]. The analysis of the flora of any given area along these lines presents many complex problems, most of which are yet to be solved.

	Total Number of Species in Group	In Arctic Alaska-Yukon	In Continental Arctic	In Arctic Archipelago	In Greenland
Widely distributed arctic species	112 *12.5*	110 *18.2*	110 *16.9*	110 *35.7*	100 *23.7*
Widely distributed southern or subarctic species	156 *17.4*	141 *23.4*	140 *21.4*	41 *13.3*	119 *28.2*
North American arctic species	28 *3.1*	20 *3.3*	22 *3.4*	26 *8.5*	10 *2.4*
North American subarctic species	98 *11.0*	47 *7.8*	87 *13.4*	17 *5.5*	24 *5.7*
North Beringia bilateral radiants.	160 *18.0*	157 *26.0*	88 *13.5*	21 *6.8*	— —
Northern Beringia endemics	53 *5.9*	53 *8.8*	9 *1.4*	2 *0.6*	— —
Cordilleran radiants	39 *4.4*	32 *5.3*	42 *6.5*	7 *2.3*	1 *0.2*
Cordilleran or western endemics	55 *6.2*	36 *6.0*	42 *6.5*	11 *3.6*	1 *0.2*
Amphi-Atlantic arctic species	33 *3.6*	1 *0.1*	26 *4.0*	22 *7.1*	33 *7.8*
Amphi-Atlantic subarctic species	84 *9.4*	— —	28 *4.3*	11 *3.6*	84 *19.9*
Eastern Arctic endemics	51 *5.7*	1 *0.1*	40 *6.1*	17 *5.5*	37 *8.8*
Arctic Archipelago endemics	25 *2.8*	6 *1.0*	17 *2.6*	23 *7.5*	13 *3.1*
Total number of species in all groups	894	604	651	308	422

The first group comprises the widely distributed, circumpolar species, among which are nearly all the well-known arctic, and also many alpine plants. (Figs. 2 and 3). The subdivision of this group into arctic and subarctic species is rather arbitrary. The combined groups constitute almost one-third of the total flora; but in the Arctic Archipelago, possessing a flora that is predominantly arctic in composition, the widely distributed arctic species alone comprise over 35 per cent. Conversely, the subarctic or southern element among the widely distributed species is better represented in Greenland, the southern part of which is barely arctic.

The next two groups, here designated as North American species, include plants that are widely distributed across northern North America but are lacking, or at least have isolated stations, in Western Europe or Eastern Asia. These average about 13 per cent of the flora in the four geographic provinces. (Fig. 4.)

The largest single group in the West comprises the Northern Beringia radiants. (Fig. 5.) This group, together with the Northern Beringia endemics, according to Hultén[8], survived the Pleistocene glaciation in the hypothetical Beringia and in unglaciated parts of northwestern America and eastern Asia. In arctic Alaska-Yukon plants belonging in these two groups account for 210 species, or over one-third of the entire flora, whereas no members of these groups have reached Greenland.

The Cordilleran radiants and the Cordilleran western endemics, as the name implies, are mountain plants that even today occupy a large area of the Cordillera. (Fig.6.)

A number of them occur in mountains of Alaska and Yukon, a slightly larger number have extended their range into western continental Northwest Territories while comparatively few have reached the Arctic Archipelago and only two, Greenland.

It has been suggested by North American students of plant geography[13, 14] that the high incidence of endemism, in the floras of Newfoundland, Gaspe and elsewhere in the Gulf of St. Lawrence, may result from magnesium and calcium tolerance of these species and may not be directly connected with the glacial history of the region. Also that many of these so-called "relicts", by virtue of this tolerance, can successfully maintain themselves on soils unsuitable to other species. This is in close agreement with the findings of European investigators of the relation of plants to H-ion concentrations in soils[19] who have demonstrated that plants which thrive in a dry climate are more and more confined to calcareous soils as they approach the northern limits of their range, since those soils alone can afford them favourable physical conditions of temperature, water supply, and soil aeration.

In the discussion of arctic plant communities presented earlier, mention was made of probable developmental sequences among the various associations. A thorough study of these processes is yet to be made in most parts of the American Arctic. It will involve: first, the formation of workable concepts of community structure in arctic and alpine areas; second, a study of the relationships between vegetational change and the complex effects of frost action in the soils; and, finally, an analysis of floras in terms of the availability and inherent potentialities of the species for the composition of the communities.

Until the advent of the aeroplane, practically all botanical exploration in arctic and subarctic parts of North America had been limited to regions accessible by river or sea transportation. Vast areas in the heart of the continent and most of the mountain systems still await exploration. In spite of the more intensive exploratory work of the last decades, these regions, botanically speaking, still remain among the least known in the world.

It is a truism in scientific research that for each problem solved, several new ones arise. When we know the distribution of the arctic flora more thoroughly we shall be in a better position to work out some of the problems of its history and ecology. And when we know more about the cytology, morphology and physiology of American arctic plants, many problems concerning their taxonomy, phylogeny and methods of survival, that today are obscure, may become clear.

Large-flowered, daisy-like Matricaria ambigua *often grows near the beach.*

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The Canadian Red Cross in Other Lands

by MAX BRAITHWAITE

As a member of the League of Red Cross Societies the Canadian Red Cross is responsible, along with other signatory nations, for the relief of suffering wherever it may be in the world. And there is a great deal of suffering throughout the world today. Last year Red Cross through its junior organization, women's work and straight donations provided close to half a million dollars' worth of goods and services to help alleviate that suffering.

The 921,010 members of the Junior Red Cross alone raised over $80,000 to assist less fortunate children in other lands. This money was raised by the children themselves, by public and high school students who belong to the 30,936 branches of the Junior Red Cross. They staged bazaars, sales, shows, back-yard fairs—anything and everything that would provide a few dollars for the relief of suffering.

Where was that suffering? In Greece 350,000 homeless waifs are living in deplorable conditions. The League of Red Cross Societies informed the Canadian Junior Red Cross that these children were suffering terribly from scabies caused by the filthy conditions of their little bodies. So the Juniors in Canada provided seven tons of benzo benzoate to treat the disease along with fourteen tons of bath and laundry soap to help prevent it, at a cost of $15,750.

Streptomyacin was sent to India and Pakistan for the treatment of children with tuberculosis. Christmas parcels went to England to 14,000 orphaned children of Canadian soldiers. Stockings, sweaters and children's woollen underwear valued at $10,250 were sent to the Italian Red Cross in Rome to be distributed among needy children in northern Italy. The Juniors also provided $12,500 as their share of the upkeep of sanatoria in the Swiss Alps where children from Great Britain, France and Germany are getting the rest and fresh air they need to bring them back to health.

Besides all this the members of the Junior Red Cross, through their International School Correspondence and the International Art Program, did a great deal to help promote international friendship and understanding.

The women of Canada, too, have continued to work for the relief of suffering abroad. Working in homes, schools, clubrooms, churches or wherever is most convenient, with materials supplied by Red Cross, hundreds of thousands of women of all ages have supplied no less than 800 cases of clothing, valued at about $115,000, for shipment abroad.

Each year the Red Cross receives from the League of Red Cross Societies a list

At top:—Open-air baby clinic in Delhi. The station wagon in background was given to the Indian Red Cross by the Canadian Red Cross.

showing what goods are needed most and where the need is greatest. Then the women of each division decide what they will make and where it will be sent. During the year, for instance, the Ontario division shipped 57,209 articles overseas. Most of this was made up of layettes and children's clothing and it went to the International Red Cross for distribution in Central Europe and also in Pakistan and India. Other goods from other divisions went to Lebanon, Trans-Jordan, Syria, Greece, France, Italy, Germany and Great Britain.

In addition to the work of Canadian women and children through the Red Cross organization, the Senior Red Cross Society has, throughout the past year, made a number of outright grants for the relief of suffering and hardship abroad. The Indian Red Cross received $5,000 worth of blankets for earthquake victims in Assam, Punjab and Kashmir. Pakistan Red Cross received another $5,000 worth of blankets for flood victims in the Lahore region. Hundreds of gallons of cod liver oil, valued at $5,000, were shipped to Indonesia to help prevent sickness among the refugees.

Grants were also provided for medical supplies for the Hartford British hospital in Paris, for 1,000 grammes of streptomyacin for distribution by the League of Red Cross Societies, for furniture for the anti-tuberculosis centre in Teheran and for a variety of other purposes.

Due to the fighting in Korea millions of civilians are suffering terrible hardships. The Canadian Red Cross is ready to help these people as soon as possible. In December of last year, at the request of the United Nations, the Canadian Red Cross sent a team consisting of a doctor, a sanitary engineer and a welfare worker to help take care of the evacuees. This is just the beginning. Undoubtedly much greater contributions for the care of those whose lives have been disrupted by war will be needed during 1951.

The Canadian Red Cross backed by the Canadian people will continue to hold out a helping and compassionate hand to sufferers wherever they may be.

Children from Britain, France and Germany are cared for at the Red Cross Sanatorium at Brissago, Switzerland, on the shores of Lake Maggiore.

An English boy with a load of clothing sent by the Canadian Red Cross.

THE CANADIAN GEOGRAPHICAL SOCIETY

ANNUAL GENERAL MEETING

The twenty-second Annual General Meeting of The Canadian Geographical Society was held on February 23, 1951, in the Lecture Hall, National Museum of Canada, Ottawa. The Vice-President, General the Hon. A. G. L. McNaughton, presided.

After approval of the minutes of the twenty-first Annual General Meeting, General McNaughton gave the following report on the affairs of the Society:—

"Ladies and gentlemen, members of The Canadian Geographical Society, I regret exceedingly that our new President Air Marshal Robert Leckie is confined to his home with an attack of influenza. In consequence it devolves on me as a Vice-President of the Society to take his place on this occasion.

"First I would report to you that in December last, the Board of Directors accepted with keen regret the resignation of Mr. C. G. Cowan as President and a Director of the Society. Mr. Cowan was one of the group who successfully organized The Canadian Geographical Society in 1929; he served for fourteen years as a Director and Vice-President, and for the past seven years as President of the Society. The Directors desire to record with very real appreciation the outstanding contribution made by Mr. Cowan in the development of the Society and to extend to him our best wishes on his retirement from active business life. May I say at this time on behalf of your Board of Directors that most prolonged and careful consideration was given to the question of the selection of a successor to Mr. Cowan, and that in the result the unanimous choice fell on Air Marshal Leckie who agreed to take up the mantle and to lead the Society in the mission which we all feel to be very worthwhile—to make Canada better known to Canadians and abroad and to support in every way within our power the acquisition of new geographic knowledge by means of research and investigation and we hope in the future by expeditions to the far places carried out under our own banner.

"May I say that the Directors, one and all, are very happy in Air Marshal Leckie's acceptance and we will give him our full support.

"At this twenty-second annual meeting of the Society, the Directors are pleased to report that the finances of the Society are in excellent condition. Surpluses both on General Account and to the credit of the Geographical Research Fund have increased as a result of the year's operations.

"During 1950, fifty-eight articles appeared in the Society's publication *Canadian Geographical Journal*, dealing with the physical, economic and human aspects of the geography of Canada and foreign countries.

"Reprints of special articles continued in demand with five new editions of former reprints and thirteen new reprints published during the year—a total of almost 439,000 booklets.

"There has been a steady demand for the Society's Provincial Geographical Aspects Series and for a companion booklet dealing with the Yukon Territory published during the year.

"This year the Society was proud to produce for the Quebec Government a publication entitled 'Industry in Action in La Province de Québec'. The wide distribution of this booklet—first edition 50,000 copies—has resulted, we are informed, in a veritable avalanche of appreciative communications from widely separated parts of the world, as well as extensive editorial reference.

"In May 1950 a grant of $1,000 was made to the Arctic Institute of North America towards the Baffin Island expedition led by Colonel P. D. Baird. Col. Baird will deliver an illustrated lecture on this exploration to the Society on April 5th, in this hall.

"Four scholarships to the combined value of $1,000 were awarded to the McGill Geography Summer School, two to Canadian and two to British students.

"It is a matter for record that I had the privilege of speaking to the Society at last year's Annual Meeting on 'North American Defence', a subject to which, unfortunately, it is necessary to give increasing attention. On January 9th last, Dr. V. B. Meen spoke on 'The Great Ungava Crater' at a meeting under the joint auspices of this Society and the Royal Astronomical Society of Canada.

"The first series of lectures on Canada under the auspices of the Society and with the collaboration of the Imperial Institute was completed this month in London. These lectures have been organized by our representative in England, Mr. W. H. Corkill, and as a result of a preliminary notice in the Journal, requests were received within a few weeks for over 700 tickets, inquiries coming from as far afield as Paris and Ireland. The first lecture was on

Ontario; it was very well attended and Col. J. S. P. Armstrong, Agent-General for the province, interested and entertained his audience in a talk of very high standard. The second lecture was on Saskatchewan and, in the absence of the Agent-General, Graham Spry, the talk was given by Mrs. Spry, who enthralled her enthusiastic audience. The following lecture was given by Mr. Corkill himself, on the subject of 'Some Canadian Mammals', about which he has written several books. The final lecture of the series, on British Columbia, was delivered by Mr. Graham Gibson. Sir Harry Lindsay, Director of the Imperial Institute and President of the Royal Geographical Society expressed himself as being highly pleased at the success of the lectures, and we are pleased that through the enterprise and initiative of its European representative the Society is helping to increase interest in and knowledge of Canada overseas.

"The Society has officially adopted a red and white pennon which is shown here for the first time. This excellent design was the creation of one of our Directors, Colonel A. F. Duguid.

"Last year a questionnaire was sent to members of the Society, and through their co-operation a readership survey entitled 'The Great Discovery' was produced. The survey showed the purchasing power of the members of the Society and the extent to which the Society's Journal is read by members of the family then passed around from group to group. This market survey, compiled to meet a need of our advertising patrons, has already been of excellent service to the Society.

"This year, we will call on our more than 10,000 active members to submit nominations of friends of kindred interests who are ready to share in the Society's aim of making Canada known at home and abroad. We ask your co-operation in an endeavour to make more of our 80,000 readers members in their own right.

"The Directors are particularly happy to express to the Executive-Secretary, Gordon Dallyn, and to the members of the staff their appreciation of the excellent services rendered during the year."

The report of the Honorary Treasurer was then adopted and upon submission of the report of the Nominating Committee ten Directors were elected for a three-year term of office, including two new Directors, Mr. V. W. Scully and Mr. D. M. Coolican of Ottawa. Three new Directors were elected to fill vacancies for one-year terms of office: Major-General H. A. Young of Ottawa, Mr. Conrad S. Riley of Winnipeg, and Dr. H. J. Rowley of Fredericton.

At the conclusion of the business proceedings, the Vice-President introduced the guest speaker, Dr. J. T. Wilson, O.B.E., a Director of the Society and Professor of Geophysics at the University of Toronto. Dr. Wilson gave a most interesting talk; in the first part he touched on theories of mountain building, illustrating by diagrams some of the theories currently held. He then showed in a series of charts the volcanic regions of the world where earth forces have been active in recent times or are now active and manifested by earthquakes and volcanic eruptions. Dr. Wilson followed this up by describing a trip he made four months ago to one of these active areas—the mountains and volcanoes of New Guinea. He showed very attractive colour photographs which he had taken on his journey from Sydney to the island and excellent aerial panoramas of the mountainous terrain of New Guinea where within the past fourteen years two volcanic cones, each about 700 feet high, were formed in the harbour of Rabaul and where as recently as last month one of the most severe eruptions in this century devastated an area of about 200 square miles and killed some 6,000 people. The human touch was introduced with pictures of natives and white settlers. Dr. Wilson held the keen interest of a most attentive audience.

On behalf of the Society Colonel A. F. Duguid thanked the speaker for his interesting and informative address.

Immediately following the General Meeting a meeting of the Board of Directors was held. The President and Officers of the Society were re-elected for 1951 and Dr. C. J. Mackenzie was elected a Vice-President. In appreciation of his services to the Society as Director and President, Mr. Charles G. Cowan was elected an Honorary President. Standing committees were appointed for the ensuing year.

EDITOR'S NOTE-BOOK

J. A. Brodie, a native of Newmarket, graduated from the University of Toronto with a degree in Forestry. Since then he has been on the staff of the Ontario Department of Lands and Forests and is now head of the Forest Resources Inventory Section of the division of Timber Management.

* * *

A. E. Porsild, F.R.S.C., M.B.E., Danish born and educated, was appointed botanist to the Canadian Government in 1926 and since 1936 has been curator of the herbarium of the National Museum. Mr. Porsild has spent some seventeen summers and eight winters north of the Arctic Circle and is a world authority on arctic plants.

* * *

Max Braithwaite is a free-lance writer, well known for his contribution to Canadian magazines and radio. He was born in Saskatchewan and attended the university of that province.

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IMPORTED
IN THE BOTTLE FROM JAMAICA

AMONGST THE NEW BOOKS

Guide to America

Edited by Elmer Jenkins

(Public Affairs Press, Washington, D.C., $3.75)

Many of the reviews of this book refer to it as the Baedeker of America, which can argue only a lack of familiarity with these famous guide books, for the intention in the two cases is by no means the same.

The *Guide to America* is a list of the various States alphabetically arranged, with the towns and villages in them discussed (with space proportionate to their importance) again in alphabetical order. The section devoted to each State begins with a map, and very good maps they are, for they depart widely from convention and show nothing but the state boundaries, inland lakes and inlets of the sea, and towns and villages. The cluttering lines of rivers, roads, and railways are entirely omitted. The background is ruled in parallel lines so that the shape of the state is clearly shown. An improvement would have been to include the names of the adjacent states and at least one line of latitude and longitude, even if it stopped at the state boundary. Alaska and other United States possessions are not included.

Next in order comes a reproduction of the seal of the State, its population, area (land and water), nickname, flower, and motto. Then follows a description, notes on the history, mining, manufactures, other resources, parks, and monuments, with any other features of interest considered worth mention. Each town or village is discussed in much the same way. Sometimes facts are omitted which, one would have thought, might well be included such as the Groton School in Massachusetts.

There is an alphabetical index which is useful if there is some doubt as to which State a certain town is in, but not all the places shown on the maps are in the index. Nor incidentally are all the places discussed shown on the maps, nor all the places on the maps discussed in the text.

This volume, prepared by the American Automobile Association, will be most useful to people motoring in the United States and future editions will, probably, remedy some of the first mistakes. Among these is a lack of scale on those very good maps, and an adolescent pre-occupation with "the biggest in the world". One wonders indeed if this collection of such claims to fame is not, itself, "the biggest in the world".

DOUGLAS LEECHMAN

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Modern Cartography
Base Maps for World Needs
United Nations Publication No. 1949-I-19, 1950; 95 pp. maps, bibliography.
(Ryerson Press, Toronto, $1.00)

This publication of the United Nations packs within its few pages a startling variety of information on all aspects of maps and their manifold uses. The title is misleading: actually, the publication is the report of a committee of experts who were invited by UNESCO to advise upon means of co-ordinating the cartographic activities of U.N. and other specialized agencies, and of stimulating the surveying and mapping of the world. Part I of the book contains the formal discussion and recommendations of the experts to UNESCO, while Part II is a "Study on Modern Cartographic Methods" which was prepared by the Pan American Institute of Geography and History.

The book is not to be recommended as light reading, but it does contain a wealth of data, much of it hitherto unpublished or uncollected, on the present status of world mapping, the need for sound basic maps as a prerequisite in any program of planned regional development, and the appalling lack of such maps. Teachers of geography, of history, and of conservation will find running through the pages a constant, eloquent plea for maps and more maps; a plea that is the more significent in view of the U.N.'s program for aid to "underdeveloped" areas.

Of particular interest are two infolded maps, one showing the world status of topographic mapping, the other the status of geodetic control surveys. Canadian readers will probably be surprised to find that Canada, according to the adequacy standards set by the experts, comes out not so well as China, but in fact just about on the same level as Manchuria. Our neighbour to the south, incidentally, is not much better off. The countries receiving the highest rating are those of the European continent and the United Kingdom.

The second part of the report covers the whole field of cartographic methods from the original basic surveys, through the production of topographic maps, down to the compilation of special-purpose maps such as statistical maps. Unfortunately, the field covered is so broad, and the space so limited, that only a page or two is devoted to each separate heading. This is hardly enough for even a sketchy outline of the subject, especially when it comes to such items as the application of electronic devices like Radar, Shoran, and Gee-H to geodetic surveying and aerial photograph control.

The usefulness of this book to the layman, and indeed even to the specialist, is severely limited both by the brevity and technicality of the discussion, and by its preoccupation with the cartographic problems of the U.N. and its special agencies. This shortcoming, however, is somewhat redeemed by the excellent and plentiful bibliography with which each chapter is studded.

H.N.L.

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Atlas de Cuba

by Gerando Canet, with the collaboration of Erwin Raisz
Prepared in the Institute of Geographical Exploration, Harvard University, and published in co-operation with the Department of Agriculture, Republic of Cuba.
63 pp., plus large infolded map
(Harvard University Press, Cambridge, 1949. $3.50)

A large amount of creative effort and research has obviously been put into this Atlas, which between its paper covers crams in data on everything from the geologic development of the island to detailed statistical maps of population, housing, and production. Were the Atlas printed on fine paper and bound between handsome covers, it would probably be acclaimed among the finest examples of national atlases.

Most of the maps reflect the well known cartographic style of Irwin Raisz' physiographic diagrams. This style, as well as being effectively used to give a vivid portrayal of Cuba's landscape, has been adapted with good effect to show land use, natural vegetation, and even tourist attractions.

The production of the Atlas has obviously been designed to capture the tourist trade as well as to serve its more usual purposes in schools and offices. This multi-purpose character detracts from the Atlas, for the English translations of the Spanish map legends and descriptive material are not as complete as they might be; furthermore, the layout, well designed for Spanish alone, becomes crowded and confusing in either language. The reproduction, perhaps due to the desire to put out a low-priced Atlas, is not as good as the fine cartographic skill deserves. It seems a pity that otherwise good maps should be spoiled by fuzzy printing on a cheap grade of paper, and by poor registration of the coloured plates which, for instance, leaves considerable numbers of Cuba's population living in the sea.

Despite these drawbacks, the authors have largely succeeded in their object of giving "a living picture of Cuban geography", and the decorative and informative wall map of the island, which comes infolded in the book, would alone be well worth the price of the entire atlas.

H.N.L.

* * *

The Epic of Korea

by A. Wigfall Green
(Public Affairs Press, Washington, D.C., $2.50)

With the war in Korea dominating the headlines, *The Epic of Korea* provides the reader with a great deal of background information, not only of the issues of recent years, but of that land's struggles since a civilization emerged from the mists of antiquity. Manchu and Mongolian, Chinese and Japanese have all fought on Korean soil, some to form dynasties, others to be driven back.

The early chapters, which are devoted to descriptions of the country and its people as well as their long,

(*Continued on page XVIII*)

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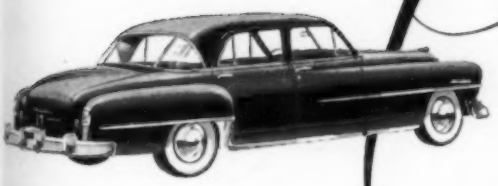

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The swing is
DEFINITELY
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(*Continued from page XV*)

violent history, are by far the best part of the book. The pages devoted to the American occupation and the various alphabetical bodies (USAMGIK, USAFIK, etc.) set up during that confusing period, are perhaps too detailed for the non-military reader. The author was stationed in Korea as a Judge Advocate during the occupation and is severely critical of the policies followed. He is now on the faculty of the Command and General Staff College of the U.S.A. at Fort Leavenworth.

But to get back to the topography of the country and the description of the people, one gets an impression of ineffable beauty in the land itself, and of a combination of high culture, squalor and poverty among the people. The Koreans were printing with movable type in the thirteenth century, long before Gutenberg, and the law of Korea was codified long before that of England. The mysticism of the people, the effect of half a dozen religions and a natural sensitivity are all reflected in the legends which are a heritage of a race made up of Ainu, Mongol, Manchu and Malay. The Korean, says Mr. Green, remains an enigma, "splendid company convivially, for he can be gay and humourous; but aroused easily to a bull-like fury that will admit no limits to his arena. He can be the most gentle of men but the dirtiest of fighters".

JAMES KINLOCH

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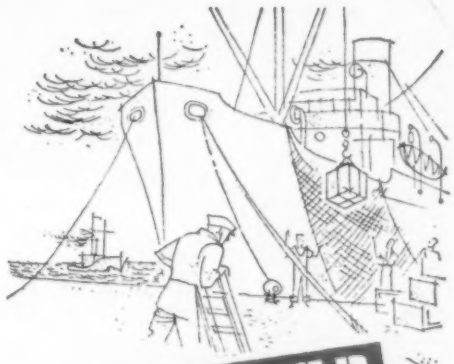

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Ontario in Your Car

by John and Marjorie Mackenzie

(Clarke Irwin, Toronto, 1950. 291 pp. $2.50)

Although written for, and dedicated to, American tourists, this little book contains many interesting facts unknown to the average Ontario citizen. Because of its brevity, many other details have necessarily been omitted.

The historical background of an area or city is sketched in with bold colourful lines. It is quite evident that the authors know far more than they have put into print, and their restraint is commendable. It would be easy to exhaust the tourist with too much detail. Pithy quotations from writers such as Susanna Moodie and Anna Jamieson whet a further interest.

The book has zest, a direct result of its authors' joy in living. They have explored Ontario thoroughly, from Quebec to Manitoba, and they know how to share their enthusiasm with others. Theirs is a first-hand knowledge of their province, where they have spent most of their lives, golf clubs, fishing rods and camera in hand.

(*Continued on page XX*)

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(*Continued from page XVIII*)

But their approach lacks provincial bias, for they view it objectively from a background of world travel. It is not a series of personal adventures, but a guide-book of accurate and specific information on where to go and why. They report on their fishing luck, on golf greens, and the type of accommodation and meals at various restaurants, resorts and hotels.

Some local pride may be hurt by faint praise and studied understatement. The authors have conscientiously avoided superlatives for the most part, a refreshing change from tourist literature.

Ontario in Your Car covers in quick thorough style each section of the province which may be reached by motor. Mileages are given in a box at the head of each chapter, and each new subject is announced in bold-face type. To make it quickly informative, bold-face has been used to indicate items of immediate interest (as *fishing*, *lunchroom*, *zoo*). While startling to the reader, it is excellent in a guide-book. This is probably the first Canadian travelbook of this particular format.

With its clear table of contents, its general index and a second index to accommodation, the book is easy to use. It is understood that the reader will undoubtedly have a road-map close at hand. It is also easy to look at, for most of the 70 photographs which illustrate the book are the work of the authors, and are of professional calibre, and well-chosen.

LYN HARRINGTON

* * *

Arabian Journey
by Gerald de Gaury
(Clarke, Irwin, Toronto, $3.00)

This is an account of a series of desert journeys in Arabia, Iraq, and North Africa made by Gerald de Gaury, who wrote *Arabia Phoenix*. The author, who has been a devoted student of the Arabs and their culture since 1924, is able to live with them on terms of intimacy equalled by few Europeans. During World War II, Colonel de Gaury raised and commanded the famous Druse Cavalry which took part in the campaign in Syria.

Here we are given a new understanding of the Arab and of the difficulties which confront him now that our Western culture is making ever more rapid strides towards his hitherto almost inaccessible land, rendering the old way of life followed by the desert tribes almost impossible today. Many local events are discussed with authority and notables described; indeed, their number becomes almost oppressive at times, except perhaps for one who has some personal knowledge of them. Particularly noteworthy is the fine description of a voyage down the Red Sea in a native sailing boat, "The Victory of the Sea".

There are many excellent illustrations, a bibliography at the end of each section, and an index. It is unfortunate that the end-paper map should have a scale which is quite obviously incorrect, giving the air-line distance from Cairo to Mecca as eleven kilometers, instead of about thirteen hundred and fifty.

DOUGLAS LEECHMAN

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